Shrimps of the Pacific Coast of Canada

T. H. Butler

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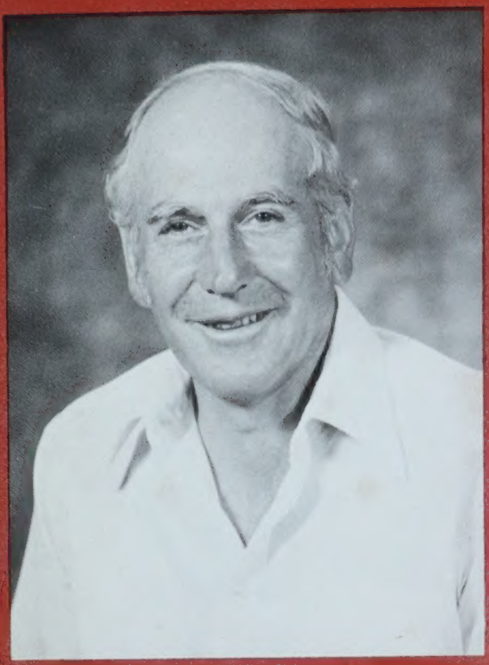
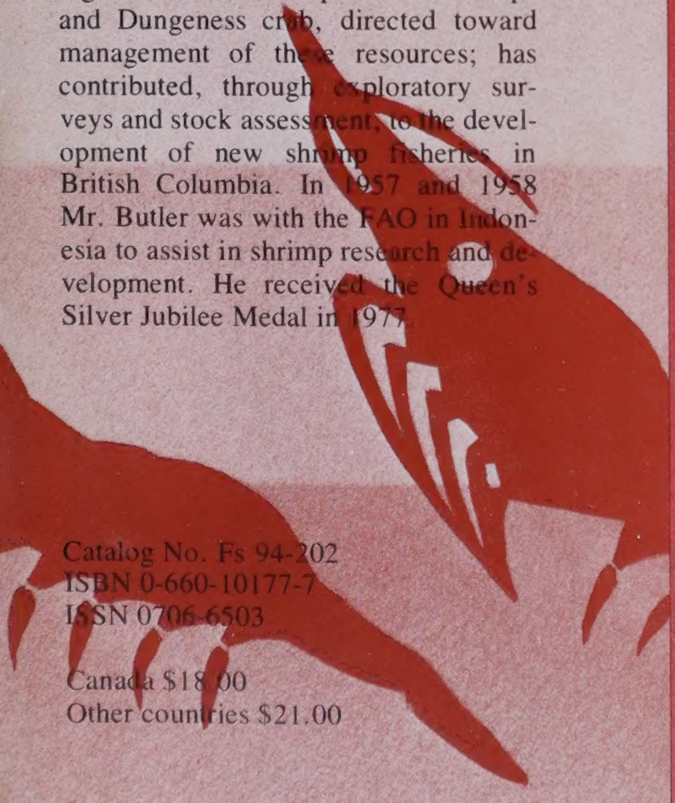


THE AUTHOR

Terrance Henry Butler was born in 1923 in Nelson, B.C. Completed secondary schooling in Victoria; graduated from the University of British Columbia, Vancouver, in 1949, and received his M.A. in 1953. During World War II he served with the Canadian Army overseas. He has been at the Pacific Biological Station, Department of Fisheries and Oceans, in Nanaimo since 1949, and is now Head of the Shellfish Program there. He has conducted biological research on pandalid shrimps and Dungeness crab, directed toward management of these resources; has contributed, through exploratory surveys and stock assessment, to the development of new shrimp fisheries in British Columbia. In 1957 and 1958 Mr. Butler was with the FAO in Indonesia to assist in shrimp research and development. He received the Queen's Silver Jubilee Medal in 1977.



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Department of Fisheries and Oceans
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Shrimps of the Pacific Coast of Canada

T. H. BUTLER

Department of Fisheries and Oceans
Pacific Biological Station
Nanaimo, B.C. V9R 5K6

DEPARTMENT OF FISHERIES AND OCEANS
OTTAWA 1980

Frontispiece: Candy stripe shrimp, *Lebbeus grandimanus,* on anemone, *Cribrinopsis fernaldi.* (Courtesy N. McDaniel and Diver Magazine)

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To my wife Joan

ABSTRACT

BUTLER, T. H. 1980. Shrimps of the Pacific coast of Canada. Can. Bull. Fish. Aquat. Sci. 202: 280 p.

This Bulletin deals with the shrimps (Class Crustacea – Order Decapoda) of the Pacific coast of Canada. The seaward limit of the region corresponds to the outer perimeter of Canada's Fishing Zone 5, i.e., 200 nautical miles (321 km) from the outer coast. Eighty-five species are listed, and each species is given a common name. Complete keys, with accompanying diagrams, are provided. Accounts of 82 species include detailed morphological descriptions and halftone illustrations, notes on color, main distinguishing characters, maximum carapace and total lengths, total known geographic and bathymetric ranges, first known local capture, and information on biology and economic importance. Seventeen species are recorded for the first time: *Bentheogennema borealis* (Rathbun); *B. burkenroadi* Krygier and Wasmer; *Sergia tenuiremis* (Krøyer); *Pasiphaea tarda* (Krøyer); *Hymenodora glacialis* (Buchholz); *Argis lar* (Owen); *A. ovifer* (Rathbun); *Crangon franciscorum franciscorum* Stimpson; *Metacrangon variabilis* (Rathbun); *M. acclivis* (Rathbun); *Spirontocaris ochotensis* (Brandt); *Lebbeus washingtonianus* (Rathbun); *L. schrencki* (Brazhnikov); *Heptacarpus carinatus* Holmes; *H. camtschaticus* (Stimpson); *H. stimpsoni* Holthuis; *Eualus herdmani* (Walker). A new species, *Heptacarpus littoralis* (family Hippolytidae) is described. Further evidence to support elevation of the subspecies *Pandalus montagui tridens* Rathbun to full specific rank as *Pandalus tridens* Rathbun is presented. The occurrence of seven species, not yet recorded, is anticipated. Included are sections on shrimp parasites, sexing of shrimps, use of keys, explanation of measurements, and also a gazetteer, glossary, partial synonymy, and index to scientific and common names. Eight plates and a frontispiece illustrate the colors of 41 shrimp species when live.

RÉSUMÉ

BUTLER, T. H. 1980. Shrimps of the Pacific coast of Canada. Can. Bull. Fish. Aquat. Sci. 202: 280 p.

Ce Bulletin traite des crevettes (classe Crustacea: ordre Decapoda) de la côte canadienne du Pacifique. La limite, vers le large, de la région correspond au périmètre extérieur de la zone de pêche canadienne n°5, i.e. 200 milles marins (321 km) de la côte. On y enregistre 85 espèces, chacune possédant un nom vernaculaire. L'ouvrage contient des clés complètes, avec diagrammes. Pour chaque de 82 espèces, on donne une description morphologique détaillée avec similigravures, notes en couleur, principaux caractères distinctifs, longueurs de carapace et totale maximales, aires de dispersion géographique et bathymétrique connues, première capture locale connue et enfin information sur sa biologie et importance économique. Dix-sept espèces sont signalées pour la première fois : *Bentheogennema borealis* Rathbun); *B. burkenroadi* Krygier et Wasmer; *Sergia tenuiremis* (Krøyer); *Pasiphaea tarda* (Krøyer); *Hymenodora glacialis* (Buchholz); *Argis lar* (Owen); *A. ovifer* (Rathbun); *Crangon franciscorum franciscorum* Stimpson; *Metacrangon variabilis* (Rathbun); *M. acclivis* (Rathbun); *Spirontocaris ochotensis* (Brandt); *Lebbeus washingtonianus* (Rathbun); L. schrencki (Brazhnikov); *Heptacarpus carinatus* Holmes; *H. camtschaticus* (Stimpson); *H. stimpsoni* Holthuis; *Eualus herdmani* (Walker). Nous décrivons une espèce nouvelle, *Heptacarpus littoralis* (famille Hippolytidae). Nous présentons des arguments supplémentaires à l'appui de l'élévation de la sous-espèce *Pandalus montagui tridens* Rathbun au rang d'espace, *Pandalus tridens* Rathbun. Nous présumons de l'occurrence de sept espèces pas encoure enregistrées. Le Bulletin continent des sections sur les parasites des crevettes, détermination des sexes, utilisation des clés, explication des mensurations ainsi qu'un dictionnaire géographique, lexique, synonymie partielle et index des noms scientifiques et vernaculaires. Nous illustrons les couleurs, à l'état vivant, de 41 espèces de crevettes à l'aide de 8 planches et d'un frontispice.

BACKGROUND INFORMATION

INTRODUCTION

A total of 85 species of shrimps, belonging to eight separate families of decapod crustaceans, live in salt water off the Pacific coast of Canada. Six species support a number of minor regional fisheries (one located on the outer continental shelf) within Canada's extended fisheries jurisdiction (200-mile limit). Occupying a variety of habitats, shrimps are an integral part of the marine ecosystem. They appear important in the diets of fishes, marine mammals such as seals and whales, and large invertebrates; and, in turn, prey on other crustaceans, many demersal and pelagic invertebrates, and can utilize dead or decaying organic matter. Yet shrimps have not received detailed treatment in ecological studies, primarily because of identification difficulties.

Two useful publications, Rathbun (219) and Schmitt (232), are not generally available; they do not deal specifically with the Canadian shrimp fauna; and are out-of-date with respect to descriptions of new species, distributional records, and changes in nomenclature. The present Bulletin is a first attempt to provide a comprehensive and apparently much-needed reference work on shrimps in the British Columbia region. It was planned originally as a handbook or field guide, with brief descriptions, basic illustrations, and keys, also to be relatively free of new taxonomic information. As the manuscript took shape, however, the author realized that a more extensive treatment was required. This has involved the preparation of longer descriptions and a set of color plates, description of a new shrimp species, and provision of other new taxonomic data; and the inclusion of a section on shrimp parasites, a gazetteer, and a partial synonymy for all local species. The net result is a volume slanted toward the technical reader. Diagrams in keys and an expanded glossary were added to assist the general reader. The format followed in this book is an adaptation of those found in the Bulletins on Canadian marine fishes by Clemens and Wilby (1961), Leim and Scott (1966), and Hart (1973).

There are great gaps in the knowledge of British Columbia shrimps. It is hoped that the present Bulletin will serve as a foundation for further research on the life histories, ecological relationships, behavior, and taxonomy of these fascinating animals.

ACKNOWLEDGMENTS

During the preparation of this Bulletin, many people assisted and cooperated in innumerable ways. It is trusted that those whose names have been omitted through oversight or lack of space will be reassured that the book could not have been prepared without their help.

First the Fisheries Research Board of Canada and later the Department of Fisheries and Oceans provided facilities and services, and an environment conducive to the extensive research necessary for this Bulletin. Through the good offices of F. C. Withler, Director of the Pacific Biological Station, the writer was freed of many regular duties during the final stages of writing. Z. Kabata, the author's supervisor, provided much direct support, advice, and encouragement, as well as reading the section on shrimp parasites. In the matter of local services, W. E. Reynolds took a personal interest in meeting the requirements of this book.

Heartfelt thanks are extended to A. A. Denbigh whose outstanding illustrations do so much to enhance the text. His keen eyes brought to light a number of characters of shrimps that might have been overlooked by the author.

The author's close associates at the Pacific Biological Station, Nanaimo, B.C., deserve special credit. A. N. Yates played an important part in the preparation of the Bulletin – collecting and identifying specimens, compiling the present gazetteer, and proof reading; J. A. Boutillier collected and identified shrimps, read parts of the manuscript, and, with N. Bourne, assumed extra administrative duties. Other present and former staff members have assisted and cooperated in a number of ways: S. J. Westrheim read part of the manuscript; F. Bernard provided information on several groups of invertebrates; N. McDaniel (West Vancouver Laboratory) supplied specimens of two shrimp species and unpublished information on their distribution and behavior; D. C. Miller donated valuable specimens from his personal collection; J. C. Scrivener made available his unpublished data on bopyrid isopods; J. G. Lindsay collected and identified shrimps; R. M. Wilson provided historical data on shrimp fisheries; J. Liston, E. R. Pollard, J. T. Ferguson, and crew members of Station vessels contributed to the success of work at sea; S. L. Poole, L. G. Clowes, and J. M. V. Nott typed the manuscript.

The author is particularly grateful for the valuable assistance and advice received from other carcinologists. F. A. Chace Jr. of the United States National Museum, Washington, D.C., improved sections of the manuscript on pelagic shrimps by his relevant comments; R. B. Manning of the same institution cooperated by arranging loans of type material and other specimens. J. F. L. Hart of Victoria, B.C., gave much appreciated aid and encouragement over the years and, more recently, furnished specimens and read the section on *Betaeus* to good effect; K. Hayashi, of the Shimonoseki University of Fisheries in Japan, generously provided unpublished observations, and checked the identification of several hippolytid shrimps. At the Auke Bay Fisheries Laboratory in Alaska, E. Haynes kindly gave advance information on larval characters of *Pandalus tridens*, and read part of the present text; and B. L. Wing cooperated by arranging loans of material in the laboratory's museum. L. B. Holthuis of the Rijksmuseum van Natuurlijke Historie in Leiden, The Netherlands, advised concerning names of carapace spines in the Crangonidae, and reviewed a section of the text. Over the years, E. E. Krygier of Oregon State University in Corvallis, OR., supplied specimens and notes on shrimp morphology, and made useful comments on sections of the text dealing with pelagic shrimps. R. A. Wasmer of Oakwood College, Huntsville, AL., read part of the manuscript and suggested additional references. L. A. Davenport of Los Angeles, CA., confirmed the identification of two bopyrid isopods. M. K. Wicksten, of the Allan Hancock Foundation in Los Angeles, answered a question on identity by examining the specimen known to the author as *Lebbeus zebra* (Leim, 1921). Collections of *Pandalus montagui* were donated by R. Couture, Direction des Pêches, Ministere de l'Industrie et du Commerce, Quebec, and P. J. Warren of the Fisheries Laboratory, Burnhamon-Crouch, England, A. J. G. Figueira of Ottawa gave advice on the new species, *Heptacarpus littoralis.* Loans of comparative material were arranged by D. R. Laubitz of the National Museums of Canada, Ottawa, Ont., and P. Lambert of the British Columbia Provincial Museum, Victoria, B.C.

HISTORICAL REVIEW

Apparently there was no scientific collection of shrimps before J. K. Lord came to British Columbia more than a century ago. This naturalist of the British America Boundary Commission collected marine animals along the east coast of Vancouver Island and in Esquimalt Harbour, before his departure for England in 1862. Four species of shallow-water shrimps were taken. Identifications were made by Bate (25), best known for his monograph on shrimps of the *Challenger* expedition (1872–76), and Lord listed them in the second of the two volume account of his activities, published in 1866 (172).

In 1878, Whiteaves (279) listed three shrimps that had been dredged in McLaughlin Bay near Bella Bella, 4 years earlier by J. Richardson of the Geological Survey of Canada. In 1880, Smith (242), an American carcinologist renowned for his studies on the Atlantic coast, described a collection of 10 different shrimps from around the Queen Charlotte Islands and elsewhere in the province by Dr G. M. Dawson, an early Canadian geologist.

Collecting up to this period had been confined to relatively shallow water. Dredging and trawling by the steamer *Albatross* of the United States Fish Commission extended exploration to abyssal depths, reaching 2938 meters west of Moresby Island. Intermittently, from August 1888 to May 1906, the vessel worked 43 stations in Canadian waters (285). An interesting sidelight is that during those years the *Albatross* occasionally took on coal in Departure Bay and at Comox. Shrimps collected at Canadian localities, along with the vast amount of material from other Pacific stations, were studied by M. J. Rathbun of the United States National Museum. Her two major publications on shrimps, in 1902 (217) and 1904 (219), reveal that 33 species were captured off the British Columbia coast by the *Albatross*. Rathbun's treatment of north Pacific shrimps remains classic; although changes in her classification have been made at the generic level, no subsequent author appears to have questioned the descriptions.

In a preliminary catalog of collections in the British Columbia Provincial Museum at Victoria, B.C., Newcombe (302) listed 10 shrimp species in 1898, several of which had not been reported earlier. This collection is no longer extant. W. A. Herdman of the University of Liverpool collected in Puget Sound and near Victoria in 1897. A year later, Walker (267) described 10 shrimps, including two species new to science, known then as *Spirontocaris herdmani* and *Crangon munitella.* They are named *Eualus herdmani* and *Mesocrangon munitella* in this Bulletin.

At the turn of the century and earlier, carcinologists were active elsewhere in the North Pacific Ocean, describing new shrimps and extending the ranges of known species. Their discoveries contributed considerably to the knowledge of Canadian shrimp fauna. Brandt (45), in studying material from A. Th. von Middendorff's travels in Siberia, named several shrimps, among them two pandalids, *Pandalus platyceros* and *P. hypsinotus.* Stimpson, one of the earliest American workers in the decade after 1856, published important papers on shrimps from California (252, 253), the western Pacific (254), and from Puget Sound (255). Dana (82), another carcinologist from the United States also working with Puget Sound collections, described four shrimps and a parasitic isopod, *Argeia pugettensis.* Dana should also be acknowledged for establishing higher taxonomic categories, such as the genus *Betaeus* and the families Pasiphaeidae and Oplophoridae, still valid today. One other American worker from this period was Holmes (128), whose main publication on Californian crustaceans in 1900 did much to pave the way for later researchers, including Rathbun. An example of Holmes' accomplishments was his clear separation of several shrimps of the genus *Crangon.* It is perhaps appropriate here to point out that Holmes and his predecessors and contemporaries wrote about other decapods and lower crustaceans as well as shrimps. Also worthy of mention is Brazhnikov (46) who, in 1907, named several shrimps, later to be assigned to the genus *Lebbeus,* the taxonomy of which is far from settled.

In 1912 Taylor (258), the first Director of the Pacific Biological Station, Nanaimo, B.C., listed 60 shrimp species that had been or were expected to be found in British Columbia waters, including 17 species he had collected, mainly from shallow water. A Pacific expedition, led by T. Mortensen from the Zoological Museum in Copenhagen, Denmark, collected two parasites of local shrimps, *Sylon hippolytes* (40) and *Holophryxus alaskensis* (56), from the Strait of Georgia in 1915.

Around 1930 three talented ladies were active in the field. In 1928, Smith (238) listed seven shrimp species she had collected near Sidney. In 1929 and 1930, Berkeley (30, 31) published two classic accounts of the biology of shrimps in the family Pandalidae. Her finding that these shrimps are protandrous hermaphrodites, i.e. each individual matures first as a male and later in life becomes a female, retains its scientific importance and fascination for the layman after almost 50 years. In the 1930s under her married name of Needler (197, 198) she wrote further descriptions of the larvae of local shrimps. Hart (109) published her first paper in 1930 concerning decapod crustaceans, including eight shrimps, collected near Victoria. She continued to publish over the years, but was more interested in the distribution and larval stages of crabs and hermit crabs. Then, in 1964, Hart (111) published a definitive monograph on the shrimp genus *Bataeus.* The key she constructed in 1971 (112) for larvae of British Columbia decapod crustaceans provides for identification, to family, of larvae of six shrimp families.

In the course of chart making by the hydrographic ship *William J. Stewart,* shrimps were collected along the west coast of Vancouver Island by E. G. Hart in 1934, and off the west coast of the Queen Charlotte Islands by C. McL. Fraser in 1935. This writer examined the collection of 238 specimens, representing 20 species, and found 2 records of distribution that are listed in this Bulletin.

Meanwhile and later, elsewhere in the North Pacific, there were developments that would have value for identification of the Canadian shrimp fauna. In 1921, Schmitt (232) published a monograph on California decapod crustaceans. New data on shrimps were presented, and Schmitt also performed a useful service by consolidating existing knowledge, so that his volume merited a place beside Rathbun's 1904 (219) publication as a standard reference work on shrimps of the west coast of North America. Yokoya published several papers in the early 1930s, one of which is cited here (297), on distribution of shrimps around the Japanese islands. A Russian lady, Kobyakova (156), published a paper on the genus *Pandalopsis,* which is still a useful reference on this group. Two of her later works (157, 158), in 1958 and 1967, provided further information about such genera as *Lebbeus, Argis,* and *Sclerocrangon.* Another Soviet worker, Makarov (177, 178), authored two papers in 1935 and 1941 that added to the knowledge on shrimp distribution in the Bering and Chukchi seas. In 1947 and 1950, Vinogradov (265, 266) produced two publications of interest for the summaries of shrimp distribution in the western North Pacific, useful keys, and the introduction of Russian common names.

Since 1948, the present author has concerned himself with life histories, distribution, and taxonomy of local shrimps. A number of papers, all cited in this Bulletin, were based mainly on collections from investigations of commercially important decapod crustaceans. The writer's colleagues at the Pacific Biological Station and investigators from outside organizations have contributed shrimp specimens. From 1960 to 1974 Bernard et al. (33, 34, 35), in the course of faunal surveys from the intertidal zone to abyssal depths, collected over 3600 specimens of 66 species, including 2 new to science, *Eualus berkeleyorum* and *Heptacarpus littoralis.* Taylor (257) collected two species, *Pasiphaea tarda* and *Parapasiphae sulcatifrons,* new to local waters. In 1955, Bousfield (42) of the National Museum of Canada conducted a survey of intertidal areas on Vancouver Island and in the Strait of Georgia; he took 313 shrimp specimens, of which 13 belonged to the new species *Heptacarpus littoralis,* and the rest to 8 other species. From dredging mainly along the east coast of Vancouver Island during 1962 and 1963, I. McT. Cowan, then of the University of British Columbia, provided 602 specimens representing 29 species. One, *Argis lar,* had not been caught previously.

Most recently, research in other areas of the North Pacific has contributed substantially to knowledge of the identity and biology of local shrimps. A marine biological expedition of the National Museum of Canada was conducted by Bousfield and McAllister (43) in southeastern Alaska and Prince William Sound in 1961. The report on the shrimp collection by Squires and Figueira (250) extended the ranges of five species northward; their preliminary description of *Heptacarpus littoralis* was of value to the present author. In 1965, Zarenkov (298) of Moscow State University, published his revision of crangonid shrimps that was followed to a large degree in the present Bulletin. Researchers at Oregon State University, Pearcy and Forss (205, 206) in 1966 and 1969, Wasmer (272, 273) 1972, and Krygier (162) 1975 contributed pertinent information on the taxonomy and biology of pelagic species. A monograph on the genus *Spirontocaris* in Japanese waters, published in 1977 by Hayashi (115), has relevance locally. Haynes (116, 117, 118), working in Cook Inlet, AK, during the last 2 or 3 years has gone a long way to completing the description of larval stages of North Pacific pandalid shrimps.

SCOPE OF COVERAGE

The present Bulletin is about shrimps, classified as crustaceans of the order Decapoda. This category does not include other shrimplike crustaceans such as "opossum shrimps" and "red feed," that belong to the orders Mysidacea (mysids) and Euphausiacea (euphausiids), respectively. Decapod shrimps are distinguished from mysids and euphausiids by: the carapace covering all thoracic somites, and normally the gills; usually a well-developed, spined rostrum; the last five pairs of thoracic appendages modified as pereiopods, at least one pair of which is chelate or subchelate; well-developed pleopods; and a stylocerite; but lacking photophores on the ventral surface of the abdomen; and a statocyst, which faintly resembles a "bull's eye," on the inner uropod. All shrimp species described here live in a marine or estuarine environment. Freshwater shrimps are not known in British Columbia. The seaward limit of the region under consideration corresponds to the outer perimeter of Fishing Zone 5[1], i.e. 200 nautical miles (321 kilometres) from the outer coast; from Estevan Point, the seaward coordinates are 46°31′39″N, 129°07′38″W and from Frederick Island, Queen Charlotte Islands, coordinates are 53°28′41″N, 138°45′24″W. Boundaries may or may not change, according to the outcome of current negotiations between Canada and the United States.

The shrimp fauna of the above region totals 85 known species. Seventeen species are recorded here for the first time – northern blunt-tailed shrimp, *Bentheogennema borealis;* Burkenroad's blunt-tailed shrimp, *B. burkenroadi;* ocean sergestid, *Sergia tenuiremis;* crimson pasiphaeid, *Pasiphaea tarda;* northern ambereye, *Hymenodora glacialis;* northern argid, *Argis lar;* split-eye argid, *A. ovifer;* bay crangon, *Crangon franciscorum franciscorum;* deepsea spinyhead, *Metacrangon variabilis;* forked spinyhead, *M. acclivis;* oval bladed shrimp, *Spirontocaris ochotensis;* slope lebbeid, *Lebbeus washingtonianus;* Okhotsk lebbeid, *L.*

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[1] Canada Gazette Pt. II, Vol. III, No. 1, January 1, 1977.

schrencki; small-eyed coastal shrimp, *Heptacarpus carinatus;* northern coastal shrimp, *H. camtschaticus;* Stimpson's coastal shrimp, *H. stimpsoni;* striped eualid, *Eualus herdmani.*

Two species were recorded earlier under different names: Krygier's spinytail, *Systellaspis cristata,* in 1971 (61) as *Acanthephyra quadrispinosa;* and candy stripe shrimp, *Lebbeus grandimanus,* in 1964 (55), as *L. polaris.* Another shrimp was listed tentatively in 1964 (55), as *Lebbeus zebra* (Leim, 1921); its identity is still uncertain. The description of a new species, *Heptacarpus littoralis,* large-eyed coastal shrimp, is included.

The occurrence of seven shrimps, not yet recorded locally, has been anticipated. Five species, *Hymenodora gracilis, H. acanthitelsonis, Heptacarpus flexus, Crangon resima,* and *Lebbeus polaris* are included in appropriate keys but no species accounts are provided. *Heptacarpus taylori* and *Pandalopsis ampla* are listed with their main distinguishing characters.

Of the 85 species recorded from the British Columbia coast, 44 species are also found to the north and south, along the west coast of North America; 10 shrimps have the northern limits and six the southern limits of their ranges in local waters. One species, Berkeleys' eualid, *Eualus berkeleyorum,* is known from Canadian waters. Fifteen species are distributed in the western, as well as in the eastern North Pacific Ocean. The ranges of eight shrimps extend into other oceans, that of another is uncertain.

Each of the 85 species has received a common name. The preferred usage by the British Columbia shrimp industry was followed in assigning five common names to commercial species: pink shrimp, *Pandalus borealis;* prawn, *P. platyceros;* humpback shrimp, *P. hypsinotus;* coonstripe shrimp, *P. danae;* and sidestripe shrimp, *Pandalopsis dispar.* The name smooth pink shrimp, coined for *Pandalus jordani* (51), has not been accepted generally by shrimp fishermen but they have as yet provided no alternative name. Common names used in other parts of the world for certain families, genera, and species of shrimps were given to the following five local species: hooded shrimp, two species of *Betaeus;* grass shrimp, *Hippolyte clarki;* glass shrimp, *Pasiphaea pacifica;* and sculptured shrimp (266), *Sclerocrangon boreas.* The generic name *Crangon* was applied directly as crangon to nine species in that genus. Twenty-five species are known here by colloquial designations of their families or genera, e.g. sergestid, pandalid, argid. Names for the remaining species were coined, with varying degrees of success.

A reference collection of the species considered in this book is deposited in the British Columbia Provincial Museum, Victoria, B.C. There is also a collection, but less complete, in the United States National Museum, Washington, D.C.

SEXING OF SHRIMPS

The most obvious sign of the sex of a shrimp is the presence of eggs on the pleopods of female specimens. This way of sexing, however, has limitations: (a) only females of species belonging to the section Caridea carry external eggs, or are ovigerous; those in the Penaeidea release their eggs, after fertilization, into the seawater; (b) female caridean shrimps are ovigerous for only part of the year; (c) only mature females will be ovigerous; (d) mature females may not carry eggs because of parasitism, or the absence of egg fertilization. Blue-green ova in the ovaries of shrimps such as *Pandalus jordani* and *P. borealis* are visible through the shell in the gastric region of the carapace for some weeks prior to the extrusion and fertilization of eggs. Fishermen refer to this condition as "eggs in the head." Through a molt immediately preceding extrusion of eggs, female carideans assume the "breeding dress," characterized mainly by the presence of long, simple, and plumose setae on the protopodites of pleopods. Some setae form a lattice for attachment of eggs, the rest apparently facilitate containment of eggs during extrusion. The presence of external eggs, visible mature ova, and breeding dress enables one, prior to and during the ovigerous season, to sort most mature females from a sample quickly, but it will be clear that more reliable methods, applicable in all cases, are required. These involve examination of the external genitalia.

Caridea – Generally, members of this category on the British Columbia coast are sexed with certainty by examining the endopods of the first two pairs of pleopods.

Second pleopod: When sexing any local caridean shrimp for the first time, one should begin with the endopod of this pleopod. On the female endopod, branching from the inner margin is a single process with minute hooklike setae on its distal end (Fig. 1B2). This is the appendix interna. On the male endopod (Fig. 1B, 16D) one will observe another structure, the appendix masculina, between the appendix interna and the inner margin of the endopod. Among males of caridean species, the appendix masculina is shorter or longer than the appendix interna, and bears spines or spinules only on the tip, or on the tip and laterally. In females of species belonging to the family Crangonidae, however, the endopod is a simple structure, lacking the appendix interna (Fig. 2D). The male endopod also lacks the appendix interna, with the spinose appendix masculina as the sole inner branch of the endopod (Fig. 2C). In *Sclerocrangon boreas* (Fig. 2E), the appendix masculina is a greatly enlarged, rodlike process, while the endopod is barely more than a stub. Reportedly (298), these structures are similar on males of other species in the genus.

First pleopod: The distal end of the male endopod has a clump of minute hooklike setae on the tip, or on the inner lobe if bifid (Fig. 1A). The female endopod is a tapered, nib-shaped structure (Fig. 1A2). The endopod on shrimps of the family Crangonidae is different; on males of the genus *Crangon,* it is short, slender, and is directed inward; the female endopod is longer, wider, and closer to the exopod. In *Metacrangon,* the female endopod (Fig. 2B) is similar to that of the male (Fig. 2A). On the whole, sexing by means of the endopod on the first pleopod is more difficult but, once sexual differences are known,

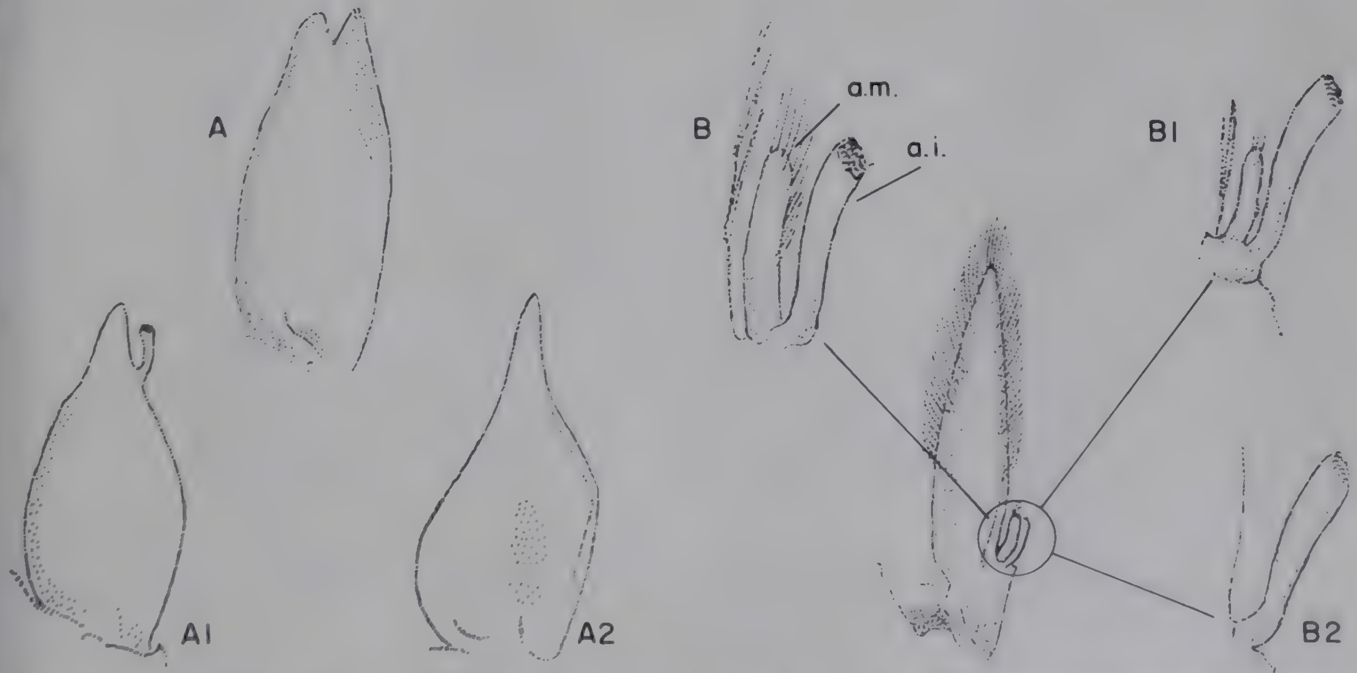

FIG. 1. *Pandalopsis dispar.* Endopod of first pleopod: (A) active male phase, (A_1) transitional phase, (A_2) female phase. Endopod of second pleopod: (B) active male phase, (B_1) transitional phase, (B_2) female phase. a.i., appendix interna; a.m., appendix masculina.

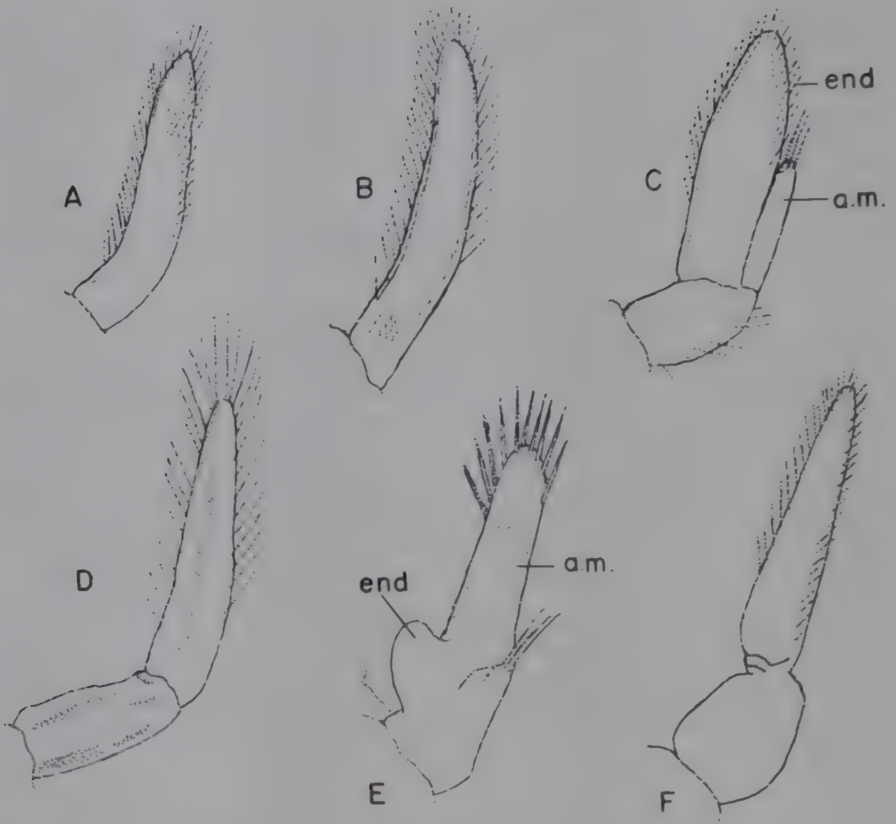

FIG. 2. *Metacrangon variabilis.* Endopod of first pleopod: (A) male, (B) female. Endopod of second pleopod: (C) male, (D) female. *Sclerocrangon boreas.* Endopod of second pleopod: (E) male, (F) female.

as in the case of species of *Pandalus,* males and females can be distinguished quicker than by examination of the second pleopod.

There is transformation of the first and second endopods in species that change sex. Male and female phases are distinguished as above. Fig. 1A1 depicts a late transitional stage wherein atrophy of the inner distal lobe of the first endopod is advanced and the other lobe is already elongated. On the second endopod of the same specimen, the appendix masculina has degenerated, losing most of the spinules (Fig. 1B1). About five moults, or changes of shell, are required for a complete transformation of the structures on the endopods. Internally the reproductive cells of the testis have ceased to be functional and the ovary is developing some time before external changes are evident.

On all shrimps, the openings of the paired ducts from the ovaries (oviducts) and testes (vasa deferentia) are located on inner margins of the coxae of the third and fifth pairs of pereiopods, respectively. These offer another, usually difficult, method of sexing shrimps. In the case of protandrous hermaphroditic species, traces of both pairs of openings are evident in either sexual phase. While the shrimp is a male, the aperatures on the third pereiopods are merely indentations in the shell, and those on the fifth pair are open, permitting the discharge of spermatazoa; later, during the female phase, the aperatures on the fifth pair tend to become blocked, and those on the third pereiopods are open, providing for the extrusion of ova.

Penaeidea — As stated earlier, eggs are not carried by female penaeideans. The endopod of the first pleopods on females is reduced on local species. In both sexes, the appendix interna is not present on any of the pereiopods.

Male: A fairly conspicuous structure on the male penaeidean is the petasma (Fig. 3A). Each half arises from the inner margin of the protopodite of each first pleopod. The petasma of each species is characteristic, making it valuable for identification (162, 190).

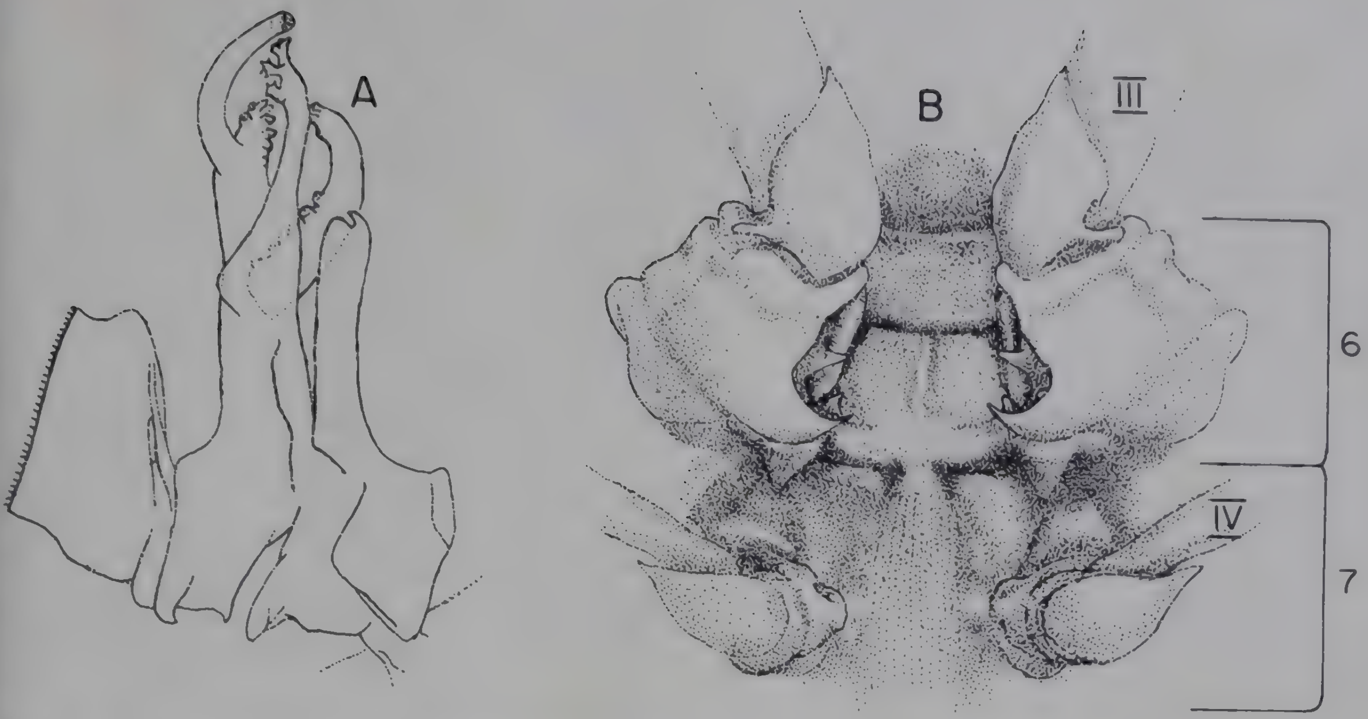

FIG. 3. *Sergestes similis.* (A) left petasma, posterior view (after Milne, 1968), (B) thelycum.

Probably at about the time of maturity, the two halves become coupled (99). The second endopod is equipped with an appendix masculina, which, on *Bentheogennema borealis* and *B. burkenroadi,* consists of two short, rounded laminae lying against each other, at the inner base of the endopod. *Sergestes similis* and *Sergia tenuiremis* each has the appendix masculina as a slightly twisted, rodlike structure. The male sexual openings on the coxae of the fifth pereiopods of penaeideans are more prominent than on carideans.

Female: The specialized reproductive structure of female penaeideans is the thelycum, formed from the modified posterior three thoracic sternites (6–8), and the coxae of the third pereiopods (that of *Sergestes similis,* Fig. 3B). This example is a relatively simple, open type of thelycum. Like the petasma, the thelycum is specific for each penaeidean species and is useful for identification as well as for distinguishing the sexes.

Other sexual differences – Generally among shrimps, males differ from females in the following: the body is smaller and more slender, the rostrum is relatively longer, antennular flagella are longer, and chelae of the first pereiopods are longer and stouter, e.g. *Betaeus.* Males of *Sergia tenuiremis* and *Sergestes similis* (Fig. 4A) have the inner (lower) antennular flagellum modified as a prehensile, or clasping organ. The male of *Hippolyte clarki* has the propodi and dactyli of pereiopods III–V modified as prehensile structures (Fig. 4B). A similar modification is found on pereiopod III of *Pandalus danae* males (Fig. 4C).

Sternal spines are located along the ventral midline, on the transverse ridges separating the abdominal sternites. In species of the family Pandalidae (186), paired sternal spines are on the ridges between the first three sternites, one spine is present on the ridge of the fourth sternite, and a median carina extends anteriorly from the ridge of the fifth sternite (Fig. 5A). The spines are acute (Fig. 5B) during the male and transitional phases of the species *Pandalus borealis, P. hypsinotus, P. goniurus,* and *Pandalopsis dispar* (186). Occasionally, late in the transitional phase, spines become weaker (Fig. 5C). Spines disappear or remain as slight protuberances (Fig. 5D) on assumption of breeding dress (186) in all preceding species, except *Pandalopsis dispar.* In *P. dispar,* sternal spines are often lost, sometimes before sex change is complete. Whether or not other species such as *Pandalus platyceros, P. jordani,* and *P. danae* exhibit the same sequence of events is uncertain (186).

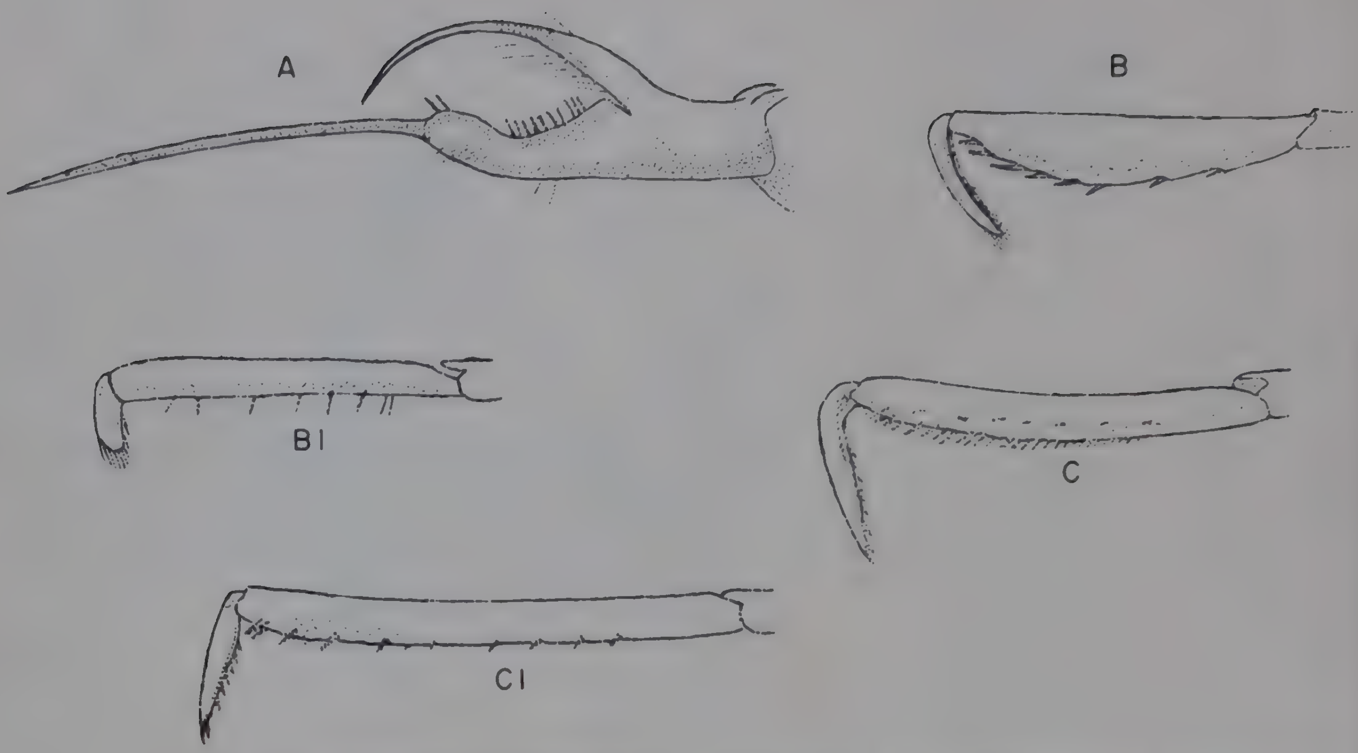

FIG. 4. Secondary sexual characters. *Sergestes similis*, (A) antennule of male; *Hippolyte clarki*, third pereiopod. (B) male, (B_1) female. *Pandalus danae*, third pereiopod, (C) male, (C_1) female.

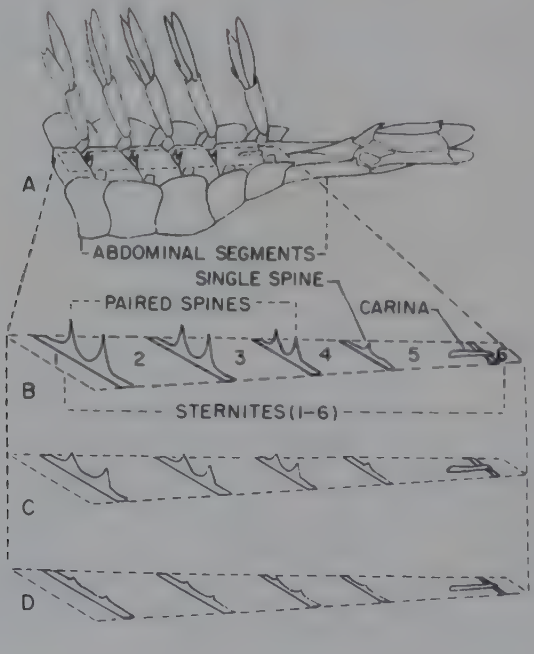
A
ABDOMINAL SEGMENTS
SINGLE SPINE
PAIRED SPINES
CARINA
1
2
3
4
5
6
B
STERNITES (1–6)
C
D

FIG. 5. Diagrammatic ventral view of abdomen of a pandalid shrimp showing location of sternal spines. (B–D) Expanded ventral views of sternal spines in prominent, reduced, and remnant stages, respectively (after McCrary 1971).

The presence or absence of sternal spines may have slight value as a method of sexing pandalid shrimps, but the main usefulness, for growth and mortality studies, is that it permits separation between ovigerous periods of newly transformed females and those that were ovigerous earlier.

PARASITES

Shrimps, as other groups of animals, have parasites. Of the 85 known British Columbia shrimps, 50 species are the primary hosts of 11 separately named parasites (Table 1). There are 10 conspicuous ectoparasites: 8 belong to the class Crustacea, 1 is a leech (order Hirudinea of the Phylum Annelida), and 1 has an uncertain taxonomic status. The endoparasite is a protozoan, belonging to the order Microsporidia.

It is well known elsewhere (236), especially in the Gulf of Mexico, that shrimps harbor the larval stages of worms parasitic on marine vertebrates. A preliminary examination of British Columbia shrimps has shown the presence of larval stages of two trematodes (flukes) and four nematodes or round worms (H. Arai personal communication). In an exceptional case (180), adult specimens of a nematode *Thynnascaris* (formerly *Contracaecum*) *adunca* (Rudolphi, 1802), normally parasitic in the digestive tract of fishes, were found on one individual pink shrimp, *Pandalus borealis.*

CLASS CRUSTACEA

ORDER ISOPODA

SUBORDER EPICARIDEA

The parasitic isopods fit into the suborder Epicaridea, which separates them from free-living isopods such as the "sow bug." The name Epicaridea means literally "on shrimps." Finally, epicaridean isopods relevant to the present work are separated into two families, Bopyridae and Dajidae. The former, known as bopyrids, are parasitic on crabs, hermit crabs, and other decapod crustaceans, as well as shrimps.

Family BOPYRIDAE

Bopyroides hippolytes (Krøyer, 1838) – This species is a branchial parasite, i.e. living on the gill surfaces of shrimps, where it can be detected by the "toothache" swelling on the side of the carapace (Fig. 6A). Normally, there is one parasite pair on a shrimp, under the carapace on either side, and only infrequently is a bopyroid pair observed on both sides of the same host. Normally living on each oval-shaped, swollen, asymmetrically, segmented female of *B. hippolytes* is a diminutive symmetrical male, whose task in life is to fertilize the many eggs produced by the female. The two appear to enter the branchial cavity during the early months of a shrimp's life. There is a direct relationship between the carapace length of the host shrimp, *Pandalus jordani,* and total length of the female *B. hippolytes* parasitizing it (J. C. Scrivener unpublished data), demonstrating that the female parasite, at least, remains on the host throughout molts of the latter, growing in concert with the host. Observable effects of this bopyroid are mentioned in species accounts of *Pandalopsis dispar* (p. 124) and *Pandalus jordani* (p. 133). Distribution of *B. hippolytes* is in North Pacific Ocean, Bering Sea, arctic Canada, east coast of North America, Greenland, Barents Sea, Norway, and British Isles (225).

TABLE 1. List of British Columbia shrimps with parasites.

Host shrimp	Parasite *Bopyroides hippolytes*	*Argeia pugettensis*	*Hemiarthrus abdominalis*	Unknown bopyrid	*Holophryxus alaskensis*	*Mycetomorpha vancouverensis*	*Sylon hippolytes*	*Trachelosaccus hymenodorae*	*Crangonobdella murmanica*	*Thalassomyces capillosus*	*Thelohania* sp.
Pasiphaea pacifica					X					X	
tarda										X	
Notostomus japonicus				X							
Hymenodora glacialis								X			
Sclerocrangon boreas									X		
Argis lar		X									
dentata		X									
ovifer		X									
alaskensis		X									
crassa		X									
Crangon dalli		X									
alaskensis		X									
nigricauda		X									
alba		X									
stylirostris		X									
f. franciscorum		X									
f. angustimana		X									
communis		X				X					
Metacrangon munita		X					X				
variabilis						X					
acclivis						X					
Mesocrangon munitella		X									
Pandalopsis dispar	X										
Pandalus borealis	X						X				
jordani	X						X				X
tridens	X						X				
danae							X				
platyceros							X				
Spirontocaris sica	X										
holmesi	X		X				X				
snyderi	X										
arcuata	X		X								
prionota			X								
Lebbeus grandimanus	X										
groenlandicus	X		X								
Heptacarpus tridens			X								
sitchensis			X								
paludicola			X								
tenuissimus			X								
brevirostris	X						X				
Eualus avinus			X								
macrophthalmus			X				X				
barbatus			X								
biunguis			X								
berkeleyorum			X								
townsendi			X								
fabricii	X		X				X				
suckleyi	X	X	X								
pusiolus			X				X				
herdmani	X										

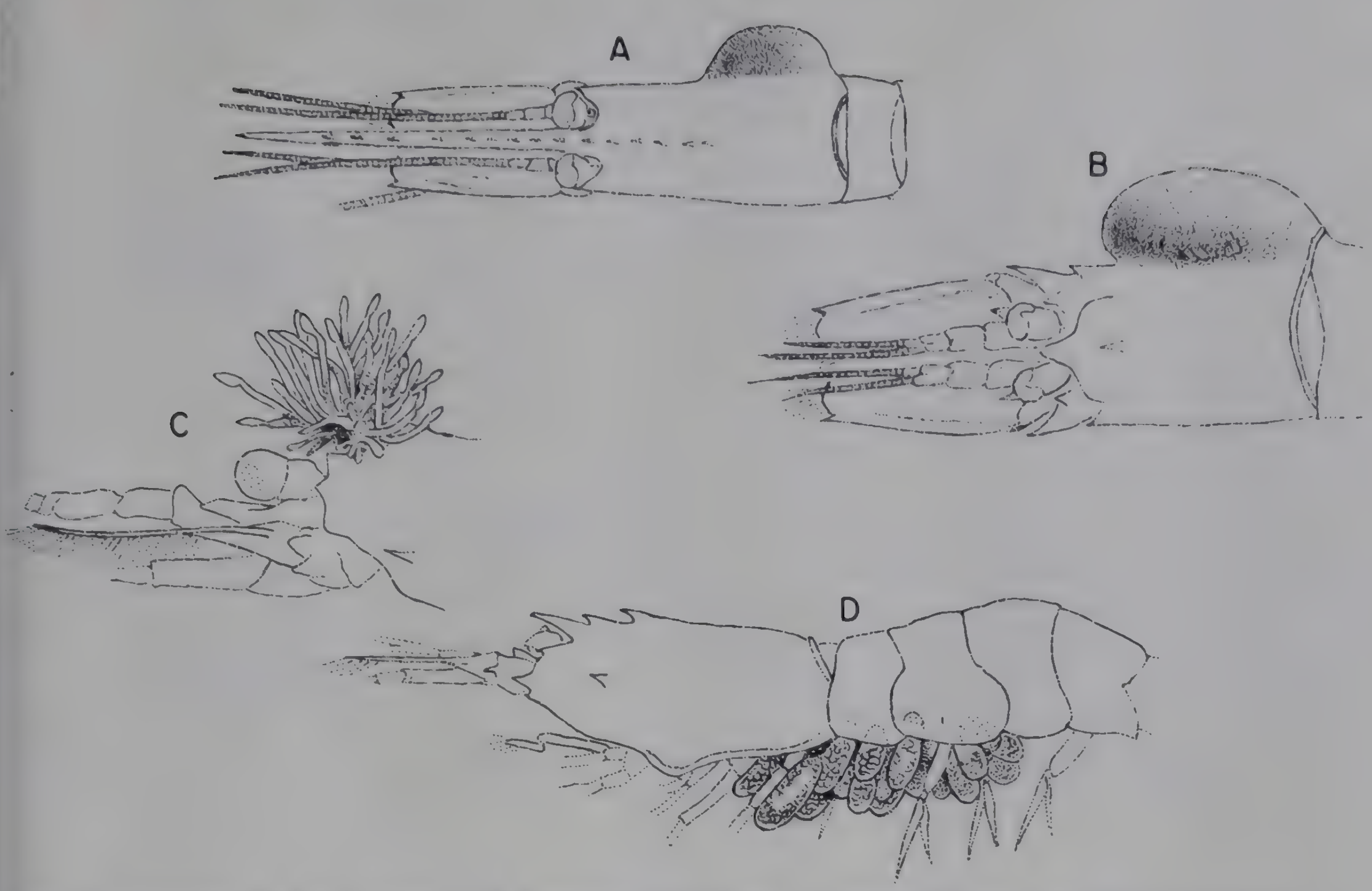

FIG. 6. Parasites on host shrimps. (A) *Bopyroides hippolytes*, on *Pandalus jordani;* (B) *Argeia pugettensis*, on *Crangon nigricauda;* (C) *Thalassomyces capillosus*, on *Pasiphaea pacifica;* (D) *Mycetomorpha vancouverensis*, on *Crangon communis.*

Argeia pugettensis Dana, 1852 – As the above, this bopyrid is a branchial parasite, living on shrimps of the family Crangonidae (225) and, oddly, on a species of Hippolytidae (100). It also brings about a swelling on the side of the carapace (Fig. 6B). One difference between a female of *Argeia* and one of *Bopyroides* is that the latter lacks pleopods (225). A pair of *A. pugettensis* may be located on either side of the shrimp, but the author has not seen a pair on both sides of a single shrimp. The effect of *A. pugettensis* on a host is mentioned in the species account of *Crangon franciscorum franciscorum* (p. 101). This bopyrid is limited in its distribution to the North Pacific Ocean, including the Bering Sea (225).

Hemiarthrus abdominalis (Krøyer, 1842) – As the specific name indicates, this bopyrid lives on the ventral surface of the host's abdomen, between the first and second pairs of pleopods (Fig. 7A). *H. abdominalis* is parasitic on shrimps of the families Hippolytidae (100, 225) and Pandalidae (225); however, infestation of the latter family is confined to regions of the North Atlantic Ocean.

Asymmetry of the female body of *H. abdominalis* is greater than that possessed by females of *B. hippolytes* and *A. pugettensis.* The small symmetrical male of the former species is not always on the female. Only one female, with or without a male, has been observed on each shrimp host by the author, and this is also the case in British waters (269). The female of *H. abdominalis* is sometimes dislodged from its position on the host but, even in its absence, the infestation may be detected by the distorted shape of the host's pleopods. Information on the biology of this bopyrid in the Pacific Ocean is unavailable. In *Pandalus montagui* specimens from the North Sea, there was a direct relationship between carapace length of the shrimp and total length of the female bopyrid; further, the parasite had no effect on sex change of the host, but development of ova was retarded

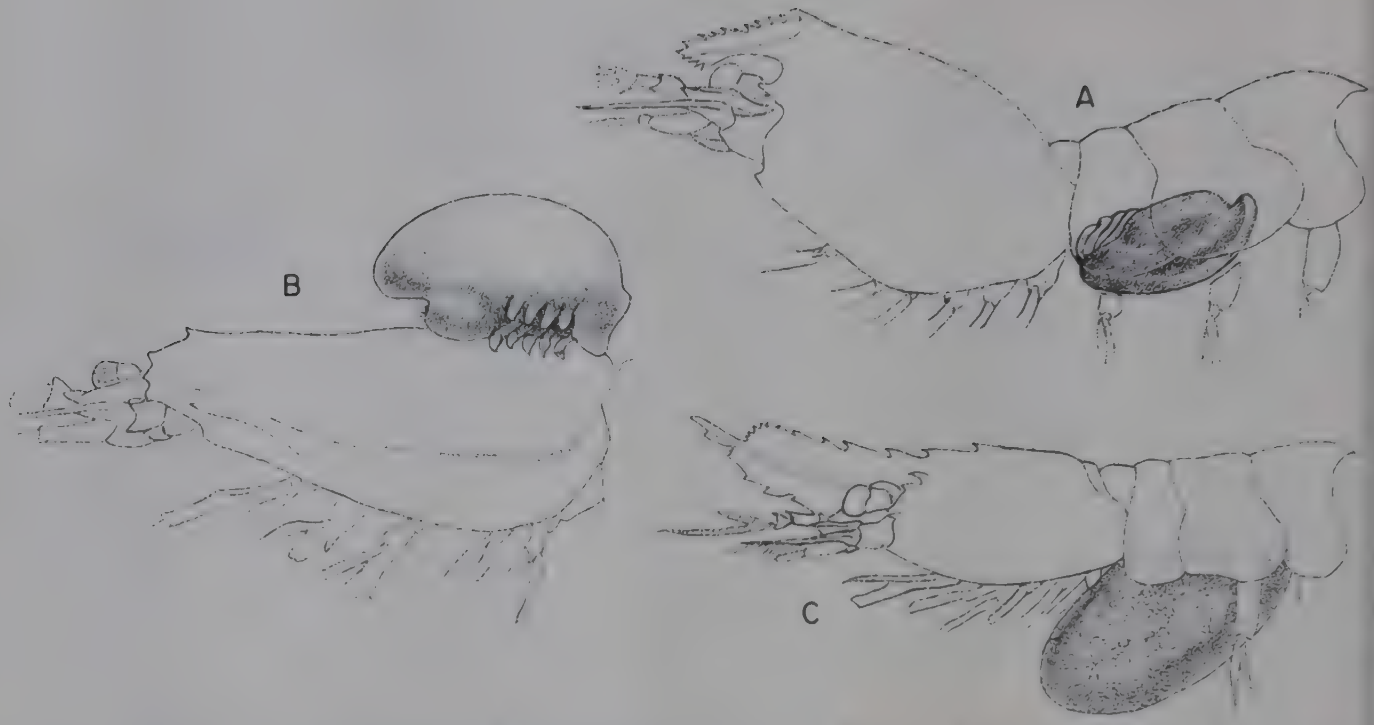

FIG. 7. Parasites on host shrimps. (A) *Hemiarthrus abdominalis*, on *Eualus berkeleyorum;* (B) *Holophryxus alaskensis*, on *Pasiphaea pacifica;* (C) *Sylon hippolytes*, on *Spirontacaris holmesi.*

(10). Relationships of *H. abdominalis* with shrimps of the genera *Spirontocaris* and *Eualus*, including *E. pusiolus*, were also described (10). The present author has not observed a parasitized specimen of *E. pusiolus* from British Columbia waters.

Mean incidence of this bopyrid on *P. montagui* off the east coast of England was 0.47% (269). Another shrimp, *P. borealis*, is parasitized off Greenland (136) but not in the North Sea (10). In the former region, male *H. abdominalis* were attached to ovigerous females of *P. borealis* (136). Incidence of the bopyrid on *P. borealis* off Nova Scotia was 0.6% (269); length data in the same paper indicate that growth of the host is retarded. *H. abdominalis* has a circumboreal distribution, occurring in the North Pacific Ocean, Bering Sea, the Canadian arctic, the east coast of North America, off Greenland, and in European waters (225).

The remaining bopyrid is an unknown species, a branchial parasite reported from a female of the mesopelagic shrimp, *Notostomus japonicus* (251).

Family DAJIDAE

These epicaridean isopods are parasitic on mysids, euphausiids, and shrimps. One species occurs on a British Columbia shrimp.

Holophryxus alaskensis Richardson, 1905 – This isopod is parasitic on the epipelagic shrimp, *Pasiphaea pacifica* (56). The female parasite attaches itself to the dorsal surface of the host's carapace, with the head region directed posteriorly (Fig. 7B). Sometimes after a parasite is dislodged, marks made by its mandibles and pereiopods remain visible on the carapace of the shrimp. One immature female was found on the ventral surface of the shrimp. Parasitic males normally live in the incubatory cavity of females, but are not present in immature females or in mature females with swollen, distorted bodies. The latter appear to be easily dislodged from their hosts.

SUBCLASS CIRRIPEDIA

ORDER RHIZOCEPHALA

Members of the subclass Cirripedia are crustaceans, commonly known as barnacles. The name Rhizocephala means literally "root-head," in recognition of the rootlike processes of the parasite within the body of the host. Rhizocephalans are parasitic on crabs, hermit crabs, shrimps, and some species are themselves parasitized by isopods.

Mycetomorpha vancouverensis Potts, 1912 – The relationship of the species to other Rhizocephala is obscure (223). Rather bizarre, as a mushroom-shaped body with numerous lobed processes (Fig. 6D), this rhizocephalan was attached to the ventral surface of the abdomens of three known shrimps, *Crangon communis* (212, 52), *Metacrangon acclivis,* and *M. variabilis* (223). Infestation of *M. acclivis* apparently is reported here for the first time. At the time of the original description (212), *M. vancouverensis* was thought to reproduce by parthenogenesis, a type of unisexual reproduction involving production of young by females that are not fertilized by males. A more recent study (223), however, revealed the presence of sperm in so-called "mantle bodies," which metamorphose from male larvae. Although one host, *C. communis,* is a common shrimp, parasitized specimens are encountered rather infrequently. Reportedly (223), only about 16 infested individuals of *C. communis* and *M. variabilis* were collected by the *Albatross* during extensive surveys in the North Pacific Ocean, 1888–1903.

Family SYLONIDAE

Sylon hippolytes M. Sars, 1870 – Over the years four publications have appeared (239, 66, 40, 41), describing the occurrence of this parasite on six species of British Columbia shrimps. Since then, *Sylon*-like parasites have been noted by the present author on *Pandalus tridens, P. jordani, P. borealis, P. platyceros,* and *Eualus macrophthalmus.* The identity of the rhizocephalans infesting each of the above shrimps is unknown but all, because of an elongate external sac attached to the ventral surface of the abdomen of their hosts, closely resemble *Sylon hippolytes* (Fig. 7C). One authority (40) considered all known species of *Sylon* to be synonymous with *S. hippolytes,* and stated (41), "Probably *S. hippolytes* is found in the whole Arctic region, in the Atlantic as well as in the Pacific;" and, "But as long as no specific characteristics can be found it is better to regard all the specimens as representatives of one species." The present author, therefore, has decided to assign all specimens of *Sylon* occurring on 11 British Columbia shrimps to *S. hippolytes,* tentatively. About all that can be stated about *S. hippolytes* locally is that their hosts, when female, are never ovigerous.

Family PELTOGASTRIDAE

Trachelosaccus hymenodorae (G. O. Sars, 1879) – This rhizocephalan, originally placed in the genus *Sylon,* was reassigned to *Trachelosaccus* (40). Members of this family are normally parasitic on decapod crustaceans such as hermit crabs. *T. hymenodorae* occurs in the North Atlantic Ocean on *Hymenodora glacialis,* a bathypelagic shrimp also present off the British Columbia coast, but the present writer has not observed the parasite.

ORDER HIRUDINEA

SUBORDER RHYNCHOBDELLAE

Family PISCICOLIDAE

Crangonobdella murmanica Selensky, 1914 – This leech was reported on female specimens of the shrimp *Sclerocrangon boreas,* caught near Point Barrow and in the Barents Sea (174). Although only one adult leech was found on an ovigerous female in the former region, egg capsules (cocoons) attached to pleopods were common. Young leeches hatch directly from capsules and probably are able to infest young shrimps (174) because the latter remain with shrimps for a while after hatching (p. 90). There is further information on the Point Barrow specimens (188). The present author has not observed adult leeches nor egg capsules on specimens of *S. boreas* caught locally.

CATEGORY PROTISTA

Family ELLOBIOPSIDAE

The taxonomic status of this family is uncertain; over the years it has been classified among protozoans, fungi, colorless algae, or protistans. The ellobiopsids are parasitic on mysids, euphausiids, amphipods, copepods, and shrimps.

Thalassomyces capillosus (Fage, 1938) – Two local pelagic shrimps, *Pasiphaea pacifica* and *P. tarda,* are hosts of this ellobiopsid. It is attached to the shrimp by a primary stalk passing through the shell, just anterior to the epigastric spine; the primary stalk branches into fingerlike processes termed gonomeres (Fig. 6C). The gonomeres produce motile biflagellate spores (289). None of the parasitized females of *P. pacifica* found in the Strait of Georgia were ovigerous. Although *T. capillosus* is common on *P. pacifica,* the author has not observed a specimen on *P. tarda.*

Another ellobiopsid, *Ellobiocystis caridarum* (Coutiere, 1911), present on the mouth parts of *P. pacifica* caught in southeastern Alaska, is an epibiont, not a parasite (289). It is reasonable to expect that close examination of shrimp specimens will reveal the presence of *E. caridarum* in British Columbia waters.

PHYLUM PROTOZOA

CLASS SPOROZOA

ORDER MICROSPORIDIA

Microsporidians infest fishes, crustaceans, and other invertebrates. One species, tentatively known as *Thelohania* sp. (264) but described as a new species, is parasitic on the local commercial shrimp, *Pandalus jordani.* Other unnamed microsporidians are parasites of local shrimps: *Crangon communis* (E. S. Iversen personal communication); *Pandalus platyceros; P. stenolepis, P. tridens,* and *P. borealis* (V. Sprague personal communication).

In *P. jordani, Thelohania* sp. produces a condition known in Gulf of Mexico shrimps as "cottony" or "milky" shrimps (236, 148). Local fishermen have likened the appearance to that of cooked shrimp. The parasite attacks and breaks down muscle fibers so the host's musculature becomes opaque. The level of incidence in *P. jordani* is less than 1% (p. 133), suggesting that the parasite is not an important factor in shrimp mortality.

There is no reason to believe that the microsporidian in *P. jordani* or the other parasites of shrimps are harmful to humans but probably people will be disinclined to eat the shrimps because of the external appearance.

OUTLINE OF SPECIES ACCOUNT

The accounts (for 82 species) follow a general format, so that comparable information is placed in the same relative position in each description. This format is also adhered to in the description of a new species, and in the change of taxonomic status of another species. When the nomenclature differs from that used in the standard works (219, 232), explanations are provided in the introductions to families and genera. Contrary to normal practice, synonyms of each species are placed in a section later in the Bulletin (p. 253).

The following is the arrangement of a species account.

Common name

The name by which the shrimp is, or may be, known in British Columbia waters.

Scientific name (author and date).

Other common names

Other names used to designate a species.

Description

Unless otherwise indicated, the description applies to both sexes. General shape of body. Shell thickness and nature of surface. Rostrum – length, relative to carapace length; formula $\frac{\text{number of dorsal spines (including those on carapace)}}{\text{number of ventral spines}}$ type of tip. Carapace spines and carinae – sequence in general, from median or dorsal to ventral. Eye – size related to body length and stoutness; cornea, well developed when black or dark, wider than stalk, well faceted. Antennule – length of peduncle related to antennal scale, i.e. short when distal end within proximal half of scale, moderately long when end around middle, long when end within distal half, or longer than scale; lengths of segments relative to one another; stylocerite length according to peduncle segments, i.e. short when not reaching end of first segment, moderately long when within length of second, long when within or longer than third segment; lengths of flagella relative to each other, to carapace, and whether exceeding tip of antennal scale. Antenna – scale length, according to lengths of carapace or telson, whether lamella exceeding spine or vice versa; basicerite, character of lateral spines or lobes; peduncle length, according to antennal scale, as in antennular peduncle above; length of flagellum, relative to body (total) length. Third maxilliped – length (extended anteriorly) with respect to antennal scale, as in antennular peduncle above, stoutness relative to same appendage of other species in genus or family, presence of exopod (length and character), and epipod (length, presence of podobranch). Pereiopods – each designated by Roman numeral, first as I, second as II, etc.; length and stoutness related to third maxilliped or preceding pereiopod; number and rows of spines or spinules mainly on flexor margins of ischium, merus, carpus, propodus, dactylus; carpus, whether segmented; whether appendage chelate or subchelate; dactylus, length relative to propodus, stoutness according to that in other species in genus or family, whether tip simple or bifid; presence of exopod (length), and epipod (length, presence of podobranch). Abdomen – sequence in general from first to sixth somite; presence and character of dorsal median carinae and posterior spines, and lateral carinae and sulci; presence and strength (weak, moderate, or strong) of ventral and posterolateral spines of pleura; sixth, length relative to fifth somite or telson, strength of posteroventral spine; telson, width relative to that of all local shrimps, presence of median dorsal sulcus, number of spines, whether dorsal, dorsolateral, lateral, or distal; uropods, lengths relative to telson and to each other. For further details see Fig. 8, 9 and Glossary (p. 235).

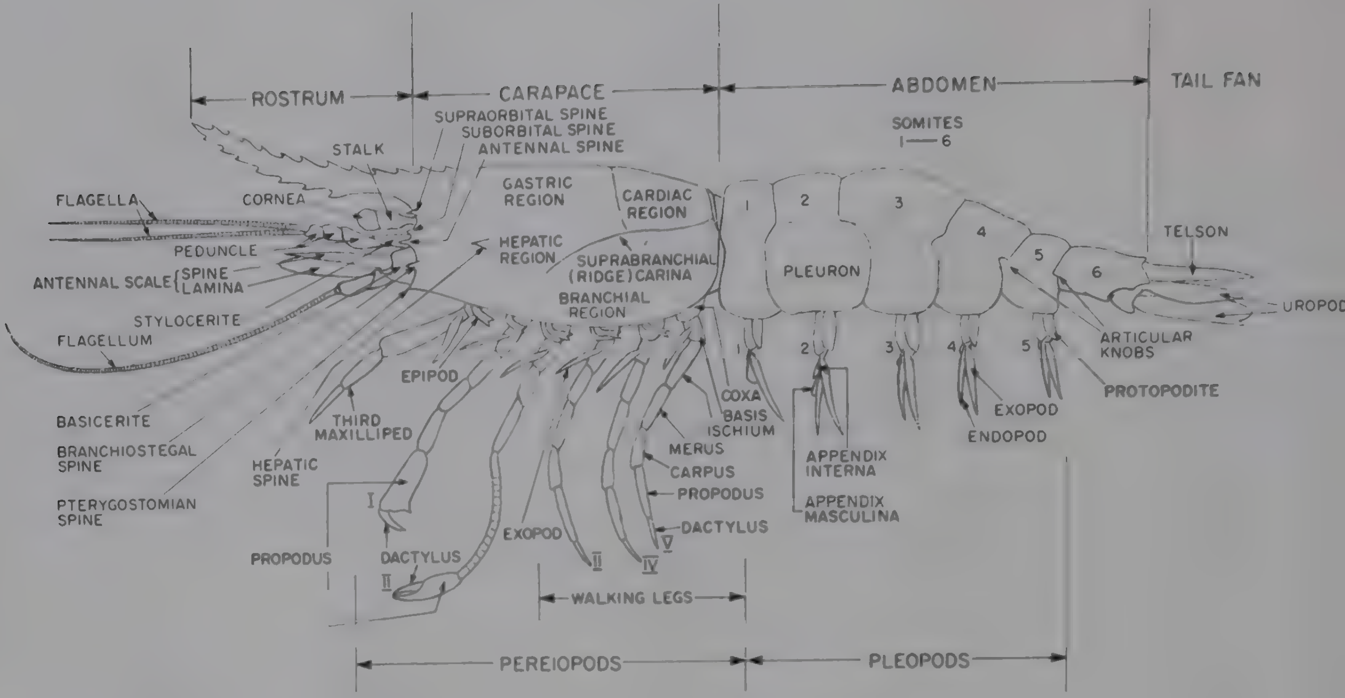
ROSTRUM
CARAPACE
ABDOMEN
TAIL FAN
SUPRAORBITAL SPINE
SUBORBITAL SPINE
ANTENNAL SPINE
STALK
SOMITES
1—6
GASTRIC REGION
CARDIAC REGION
FLAGELLA
CORNEA
HEPATIC REGION
SUPRABRANCHIAL (RIDGE) CARINA
BRANCHIAL REGION
PEDUNCLE
ANTENNAL SCALE
SPINE
LAMINA
STYLOCERITE
FLAGELLUM
1
2
3
4
5
6
PLEURON
TELSON
UROPOD
ARTICULAR KNOBS
PROTOPODITE
EXOPOD
ENDOPOD
EPIPOD
BASICERITE
BRANCHIOSTEGAL SPINE
PTERYGOSTOMIAN SPINE
THIRD MAXILLIPED
HEPATIC SPINE
COXA
BASIS
ISCHIUM
MERUS
CARPUS
PROPODUS
DACTYLUS
APPENDIX INTERNA
APPENDIX MASCULINA
I
II
IV
V
EXOPOD
PROPODUS
DACTYLUS
WALKING LEGS
PEREIOPODS
PLEOPODS

Fig. 8. Hypothetical caridean shrimp, showing terms used in species accounts.

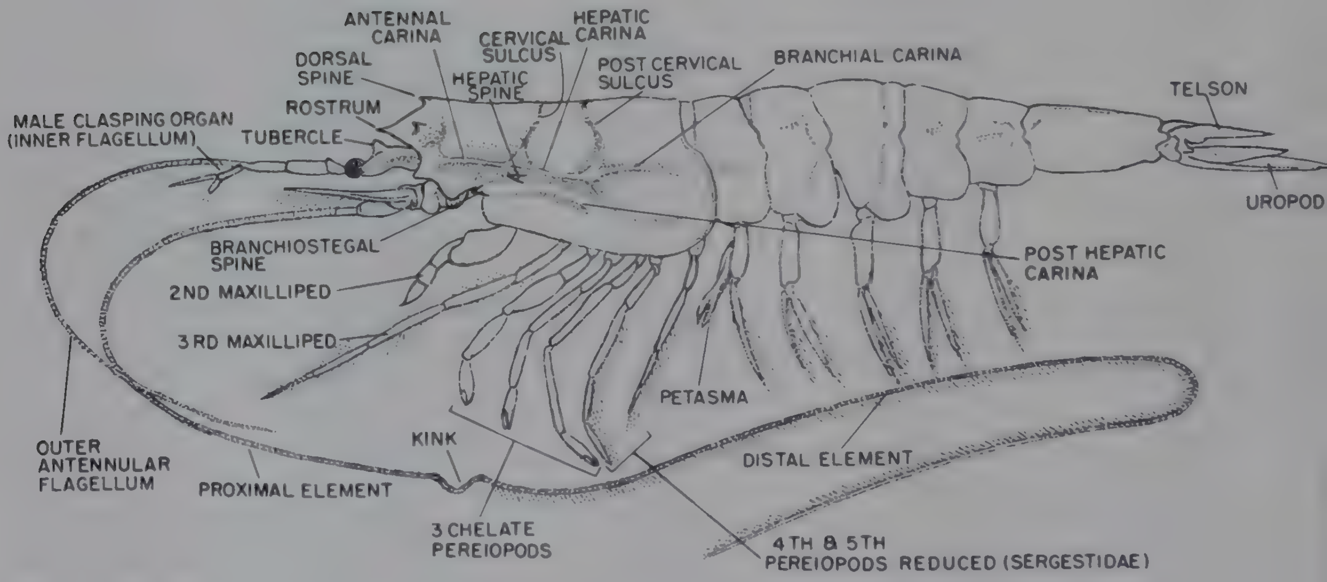
ANTENNAL CARINA
HEPATIC CARINA
DORSAL SPINE
CERVICAL SULCUS
HEPATIC SPINE
POST CERVICAL SULCUS
BRANCHIAL CARINA
TELSON
MALE CLASPING ORGAN (INNER FLAGELLUM)
ROSTRUM
TUBERCLE
UROPOD
BRANCHIOSTEGAL SPINE
POST HEPATIC CARINA
2ND MAXILLIPED
3 RD MAXILLIPED
PETASMA
OUTER ANTENNULAR FLAGELLUM
KINK
DISTAL ELEMENT
PROXIMAL ELEMENT
3 CHELATE PEREIOPODS
4 TH & 5TH PEREIOPODS REDUCED (SERGESTIDAE)

Fig. 9. Hypothetical penaeidean shrimp, showing terms used in species accounts.

Remarks

Includes information and comments on morphology and taxonomy; and derivation of common names, especially if a tribute to a person.

Color

Notes on colors of living or freshly caught specimens. There is a reference to a color plate fo each of 41 species.

Distinctions

For each species, there is a set of one or more characters that distinguish it from other closely related species; some characters for the larger species are applicable at sea or on a beach, but many are only of value when there is access to a low-power binocular microscope.

Maximum lengths

Carapace and total lengths (in millimeters) are given for each sex; unless references are cited, lengths are of specimens collected locally.

Range

Total known range is given, with references. Locations of most places are found in the Gazetteer (p. 245). Depths are in meters (1 fathom = 1.83 m). The first known capture of each species in British Columbia waters is stated.

Biology and economics

This category contains available information on abundance, life histories, behavior, ecological relationships, parasites and their effect on the host, population dynamics, commercial utilization, and economic importance for each species.

In the appropriate categories above, lack of references to the literature denotes that data have been provided by the present author. Each citation is indicated by an index number that identifies the pertinent publication in References (p. 263).

EXPLANATION OF MEASUREMENTS

Carapace length was measured from the posterior middorsal margin to the posteriormost part of the orbit. Normally a vernier caliper was used, but it is usually easier to measure small specimens by a micrometer eyepiece.

Total length was taken from the tip of the rostrum to the tip of the telson of shrimps fully extended, but not stretched. A shrimp can be measured against the scale on a caliper, or on a measuring board. Total lengths of shrimps are seldom taken in current studies because the procedure is slow and subject to some error; besides, the rostrum or telson, or both, are sometimes broken during capture. The measurement is included in this Bulletin for possible comparisons with total lengths in the early literature, and also for the general reader who is inclined to think of shrimps in terms of total lengths.

The length of the rostrum was measured in a straight line from the tip to the posteriormost part of the orbit. It is taken easily with a caliper with jaws for inside measurements. An actual rostral length has little meaning unless it is expressed as a ratio of the carapace length, obtained by dividing the latter into the former. In species of the family Pandalidae this ratio or quotient is greater for males than for females, and the same appears true in many other shrimps.

Length of the antennal scale was taken from its base to the tip of the lamella or spine, whichever was the most distal point. Calipers or dividers may be used. Scale length relative to carapace or telson length is of value in the present work for the identification of certain shrimps, e.g. in the genus *Heptacarpus*.

The length of each segment (podomere) of the second and third maxillipeds and pereiopods was measured along the extensor margin with the appendage fully extended. Any segment length is expressed in terms of other segments of the same appendage.

Length of telson was taken from the base (dorsal midline) to the tip (distal spines excluded) with the telson fully extended.

Lengths of the fifth and sixth abdominal somites were measured along the dorsal midline with posterior spines excluded.

USE OF KEYS

Keys form an almost indispensible part of any taxonomic publication. They are devised essentially as an aid for the identification of organisms, and are not necessarily based on natural relationships. Keys in the present Bulletin, in accord with the taxonomic arrangement of shrimp species, appear at four different levels. Included in most keys are line diagrams, illustrating diagnostic characters.

To identify a shrimp, turn first to the Key to Sections of the Natantia (p. 39), and determine, by use of the series of numbered alternative statements, whether the specimen belongs to the Caridea or the Penaeidea. Then proceed step-by-step through keys to families, genera, and species under the particular section. The final step should lead to the identity of the correct species. Reference to the detailed information and illustrations in the species account will assist the reader in confirming identification.

In keys to species of five genera of caridean shrimps, the scientific names (with authority and date) of those species expected to be found locally in the future are set in square brackets. Keys to families and lower taxonomic categories in this book were designed to separate shrimps in this region, and could be misleading if used elsewhere.

SPECIES ACCOUNTS

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- C. Striped eualid, *Eualus herdmani*
- D. Rough argid, *Argis crassa*
- E. Krygier's spinytail, *Systellaspis cristata*
- F. Pacific sergestid, *Sergestes similis*

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- A. Prawn, *Pandalus platyceros*
- B. Dana's bladed shrimp, *Spirontocaris lamellicornis*
- C. Rough patch shrimp, *Pandalus stenolepis*
- D. Horned shrimp, *Paracrangon echinata*
- E. Pink shrimp, *Pandalus borealis*

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- A. Grass shrimp, *Hippolyte clarki*
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- A. Coonstripe shrimp, *Pandalus danae*
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31 Plate 5
- A. Berkeley's eualid, *Eualus berkeleyorum*
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- A. Alaska coastal shrimp, *Heptacarpus moseri*
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- A. Humpback shrimp, *Pandalus hypsinotus*
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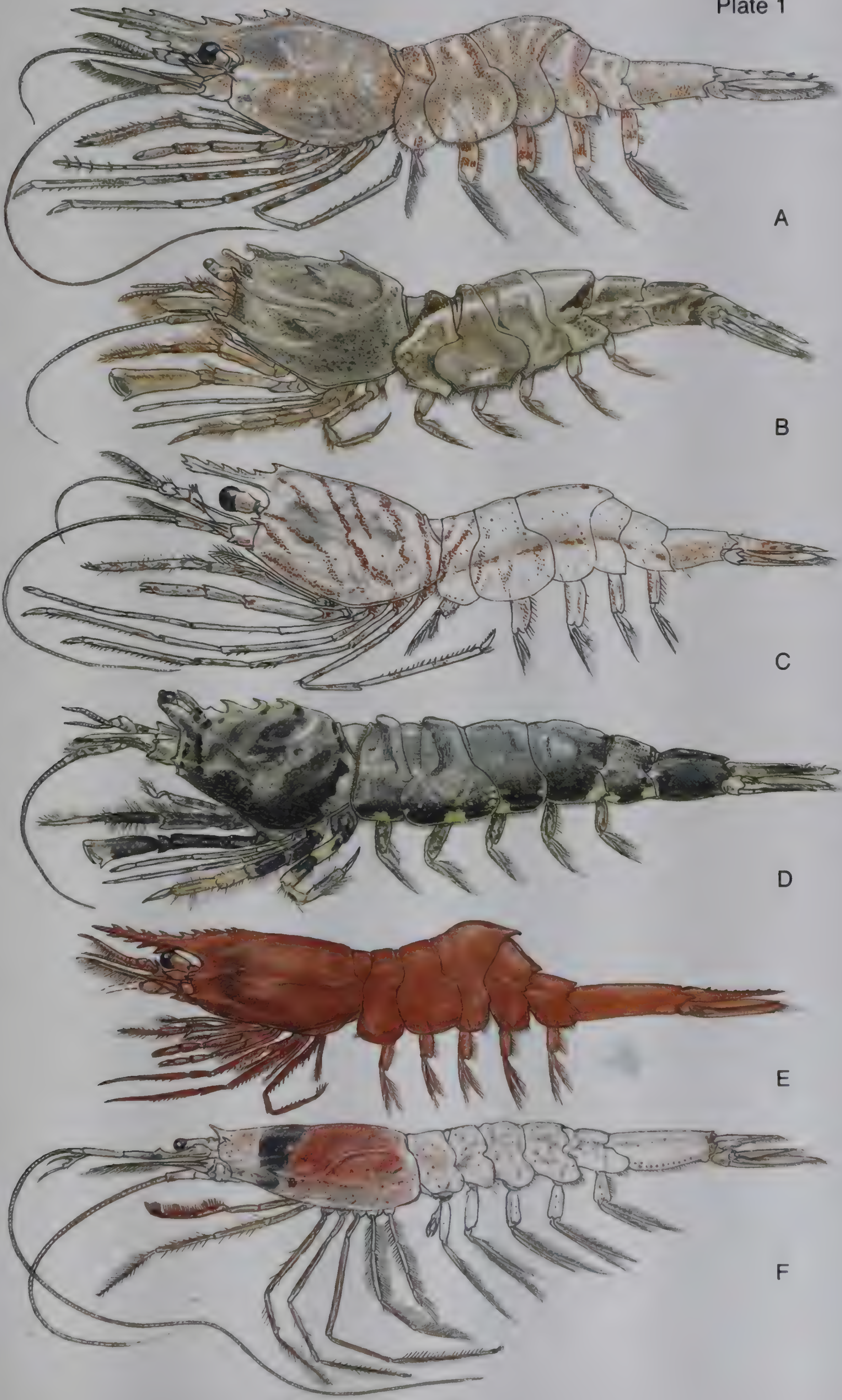
- A. Large-eyed eualid, *Eualus macrophthalmus*
- B. Yellow-leg pandalid, *Pandalus tridens*
- C. Townsend's eualid, *Eualus townsendi*
- D. Sidestripe shrimp, *Pandalopsis dispar*
- E. Beaked eualid, *Eualus avinus*

Plate 1



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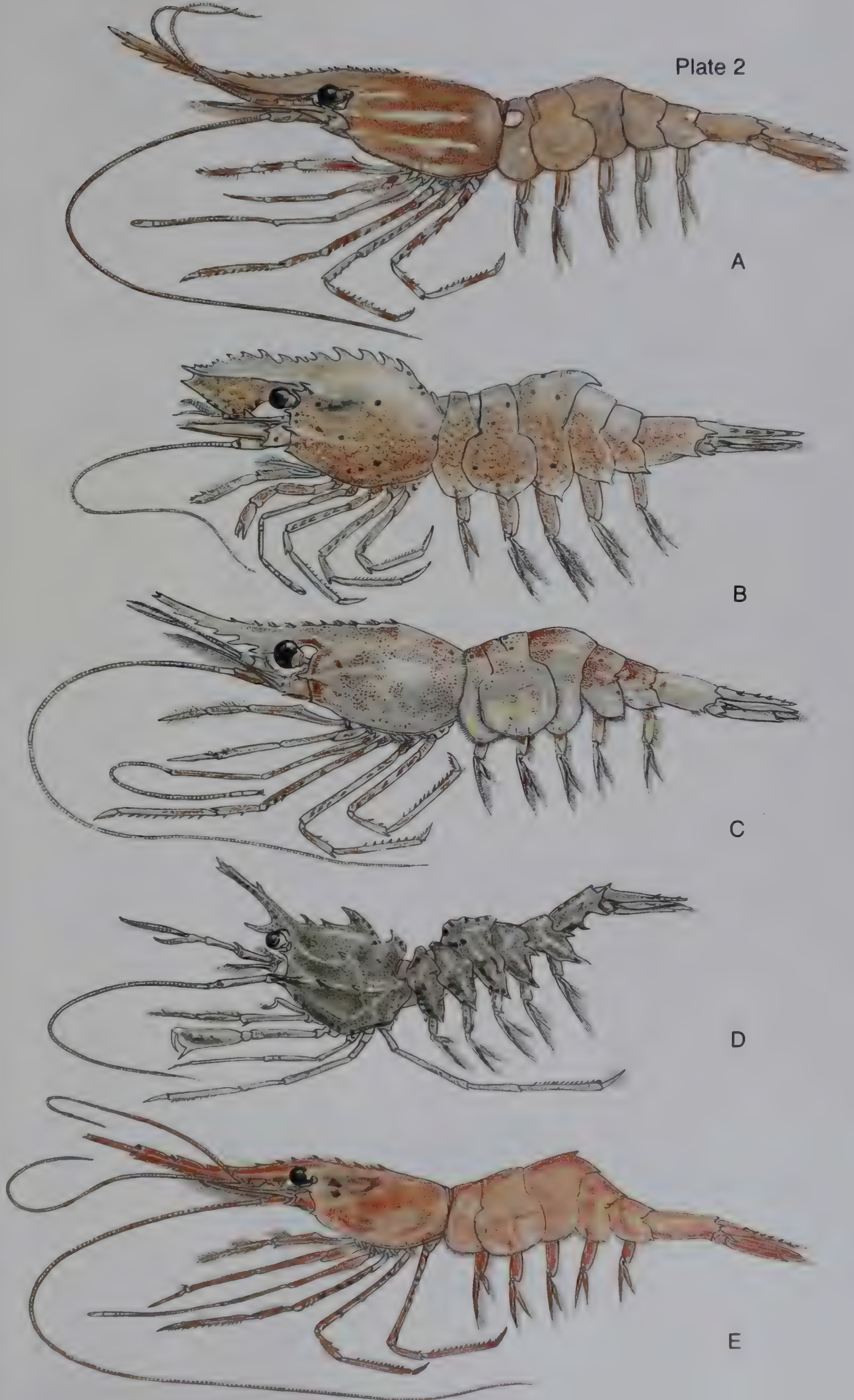

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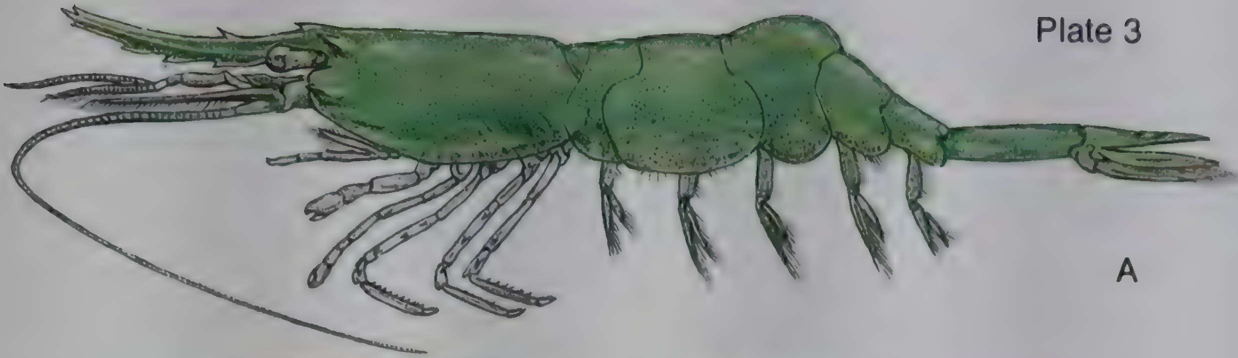

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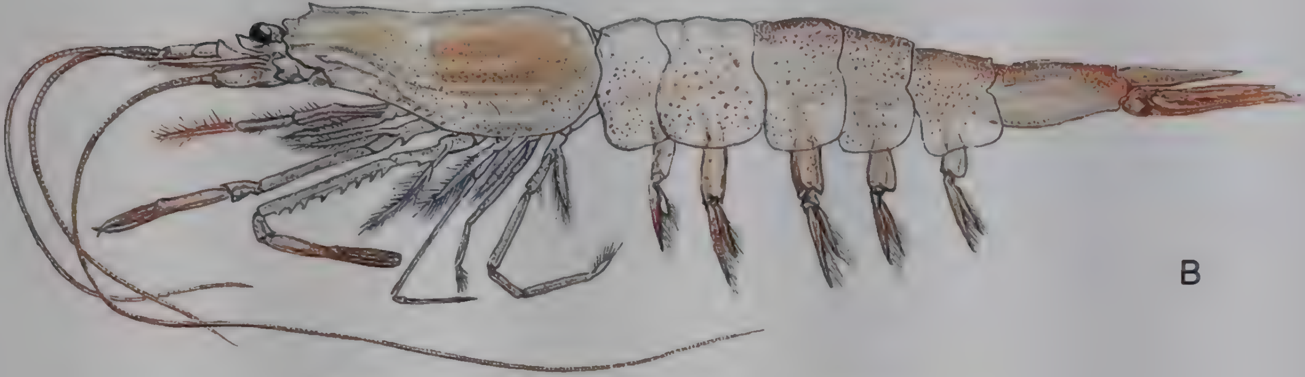

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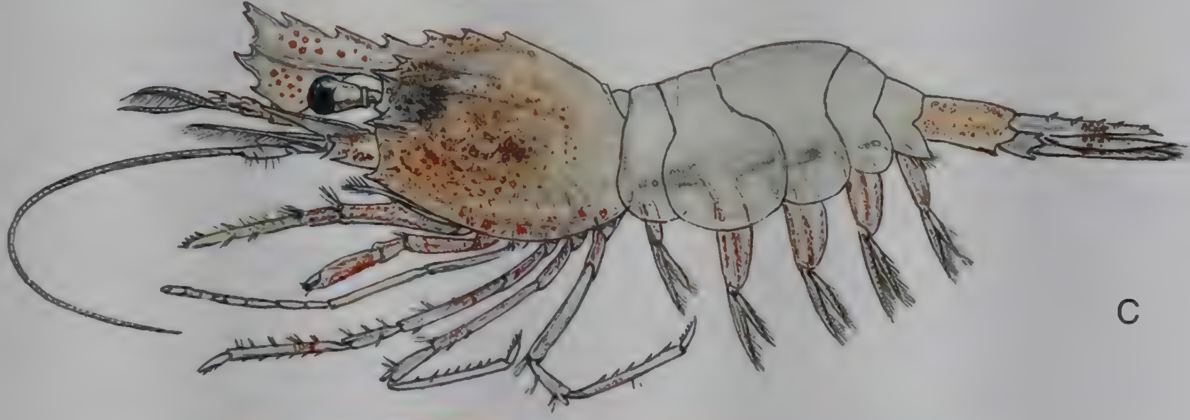

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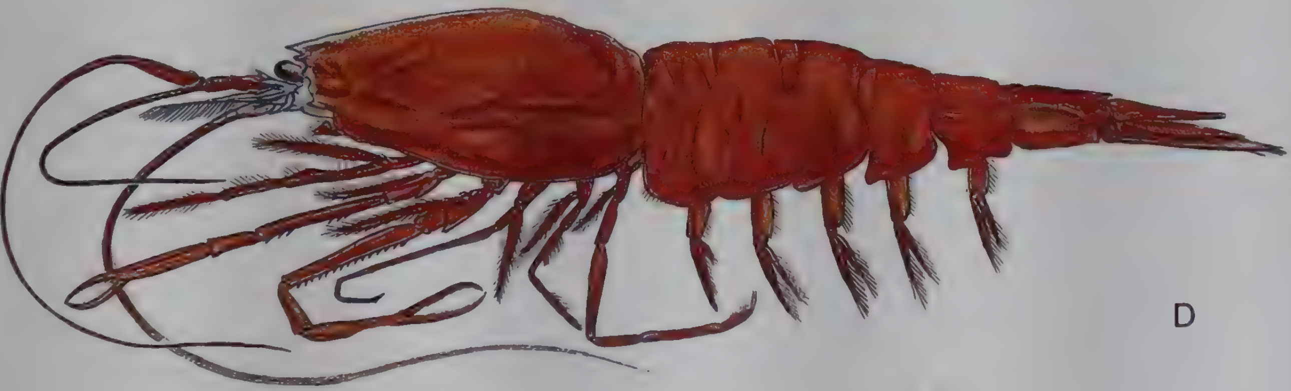

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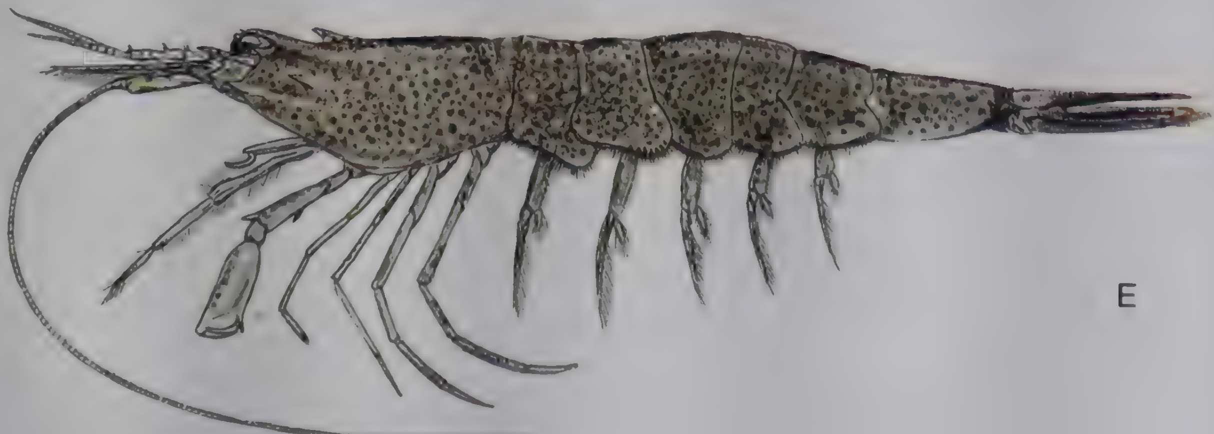


E

Plate 4

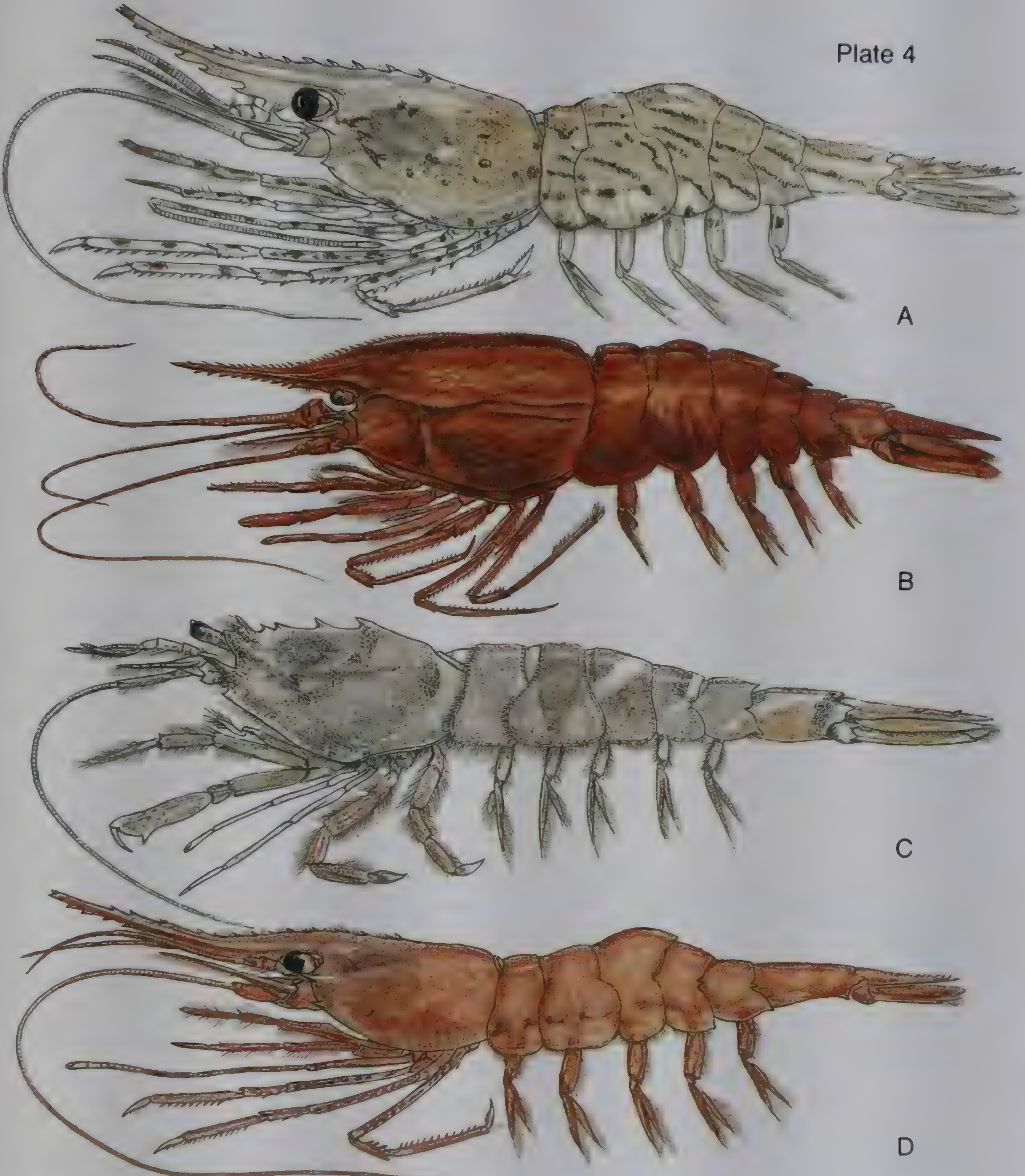


Plate 5

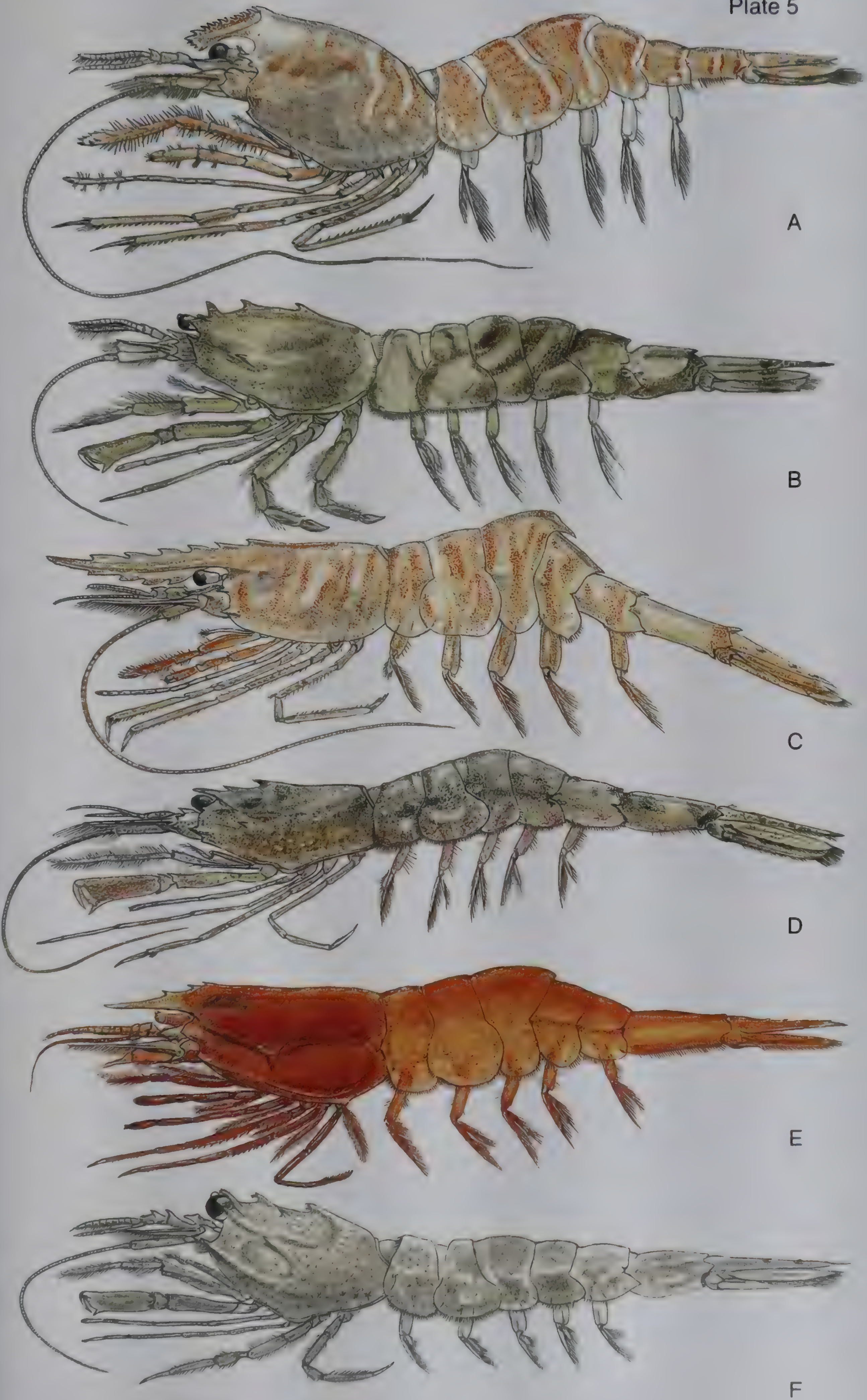


Plate 6

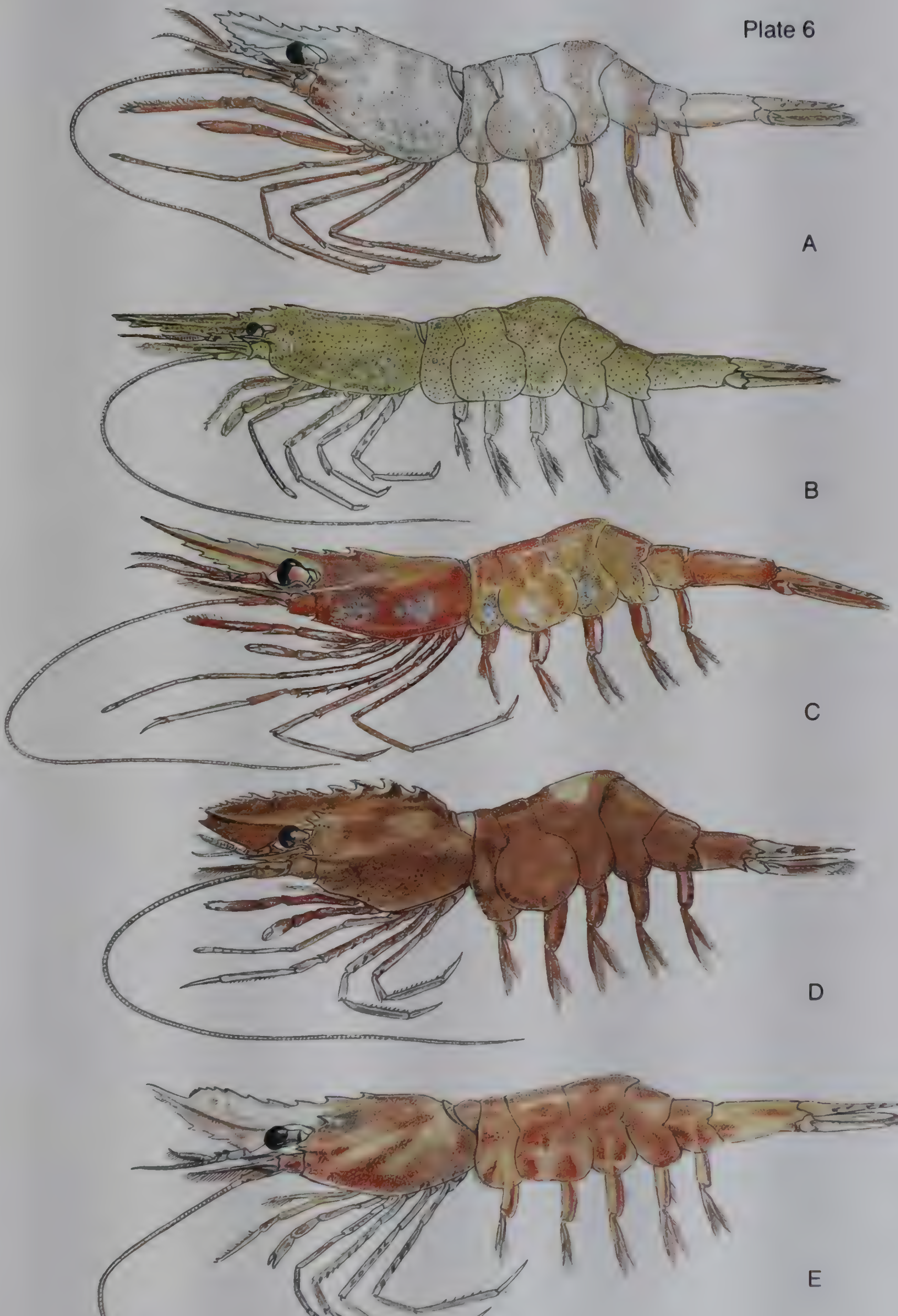


Plate 7

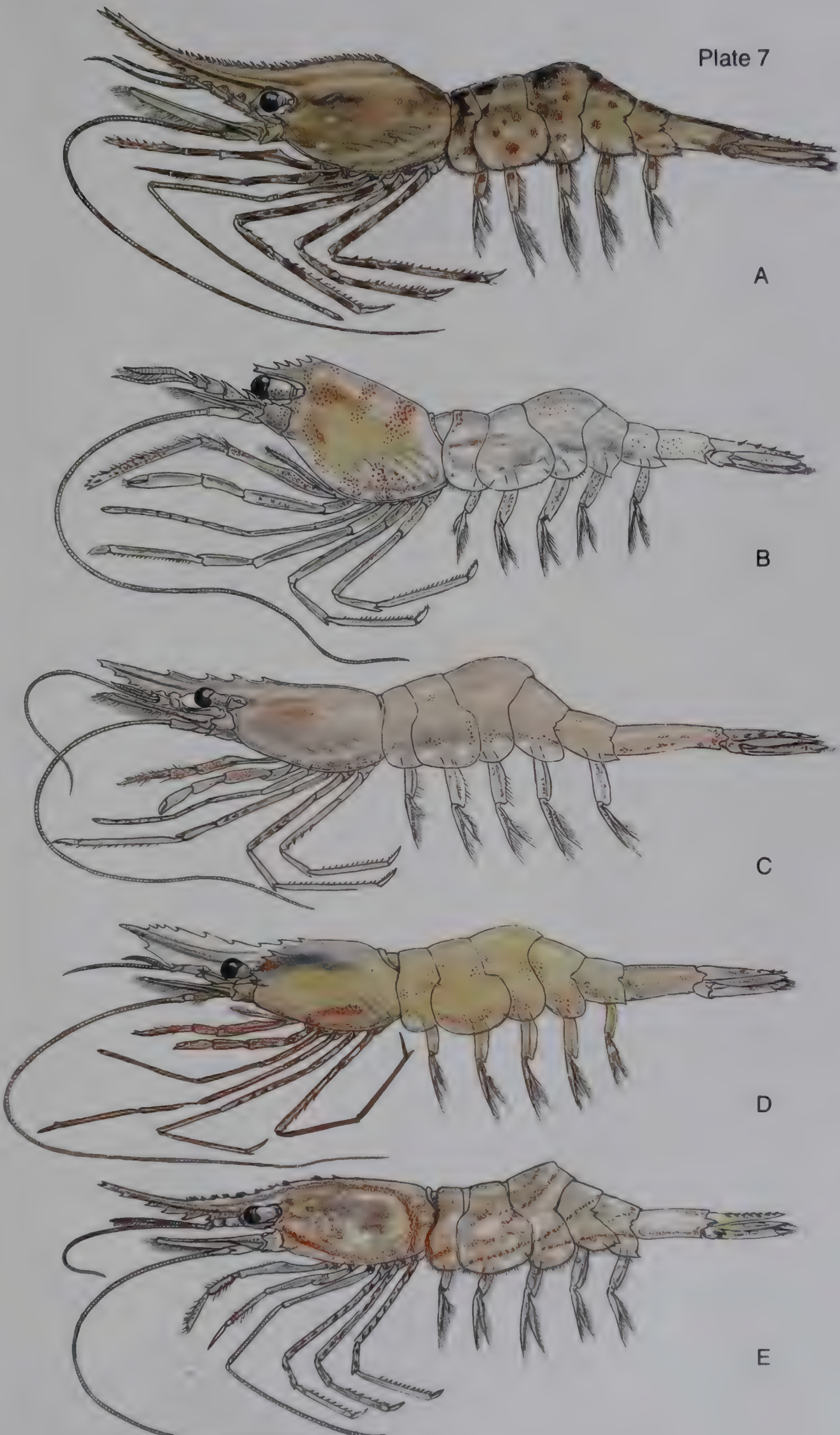
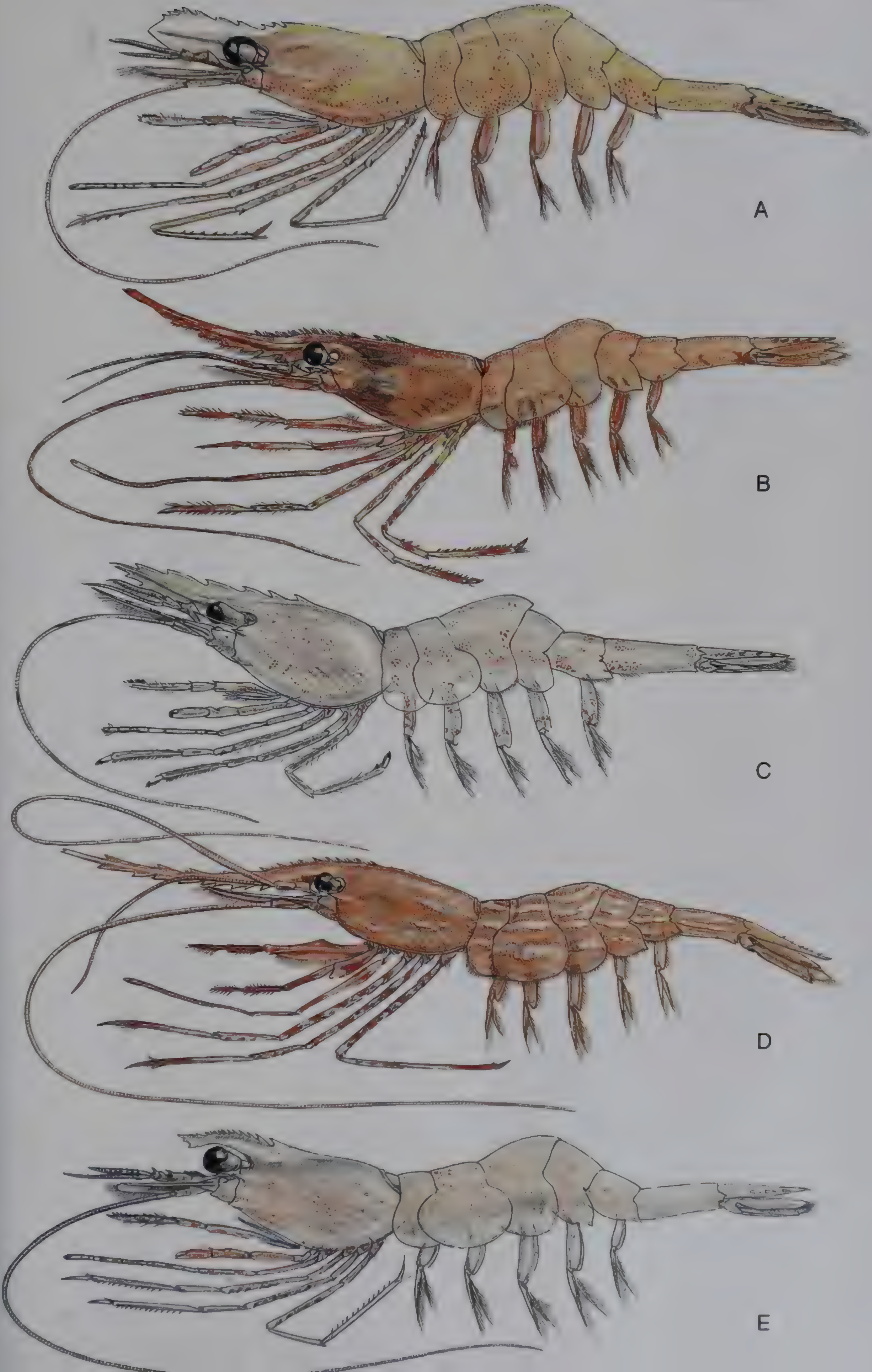


Plate 8

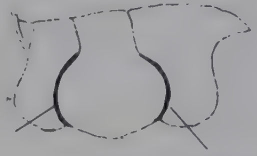


SUBORDER NATANTIA

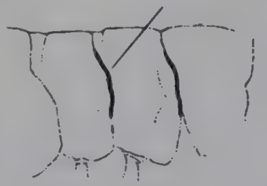
The Natantia, to which the true shrimps and prawns belong, is one of two main categories of the order Decapoda. Crabs and hermit crabs fit into the suborder Repantia. The name Natantia is derived from the Latin verb "nato," to swim. Members of the suborder are characterized as follows: body in most cases laterally compressed; rostrum usually compressed and serrated; first abdominal somite not much smaller than others; antennular peduncle generally with stylocerite; antennal scale generally large and lamellar; pereiopods usually slender, except sometimes a stout limb or pair, which may be any of first three pairs, sometimes with exopods; five pleopods always present, well developed for swimming. For general data on distribution, taxonomy, and population dynamics of shrimps see (11, 47, 130, 218, 249, 241).

Key to sections of Natantia

(After Holthuis (131))



1 Pleura of second abdominal somite overlapping those of first and third pleura; no chelae on third pereiopods, abdomen usually with sharp bend or hump .... Caridea (p. 51)



Pleura of second abdominal somite not overlapping those of first somite; third pereiopod chelate; abdomen without sharp bend or hump 2

2 Third pereiopod distinctly larger than first and second; males without petasma, females without thelycum .... Stenopodidea (no representatives in British Columbia waters)

Third pereiopod never larger than first and second; normally all chelipeds of equal size; males with petasma, females with thelycum .... Penaeidea (p. 39)

SECTION PENAEIDEA

Abdomen not flexed sharply. Pleura of second abdominal somite not overlapping those of first and third somites. Third pereiopod never longer and stouter than first and second. First pleopods of male modified to form petasma; appendix masculina present on endopod of second pleopod. Sternites of thoracic somites, to which are attached the third to fifth pereiopods, of females, modified as thelycum. Endopod of first pleopod of female reduced or absent. No appendix interna on any pleopods of either sex. Eggs not carried by females.

More than 300 known species are found in a marine environment. Species of two families that occur in British Columbia waters inhabit pelagic zones.

Key to families of PENAEIDEA

1 First to third pereiopods chelate; fourth and fifth pereiopods well developed; inner or lower antennular flagellum normal; gills numerous ... Penaeidae (p. 40)

First pereiopod not chelate; fourth and fifth pereiopods reduced; inner or lower antennular flagellum of male modified as clasping organ; gills few .... Sergestidae (p. 45)

Family PENAEIDAE Bate, 1888

Rostrum compressed laterally, normally well developed. Gills numerous. No pereiopo reduced in size; first three pereiopods chelate. Third maxilliped pediform, of seven segments Inner antennular flagellum normal.

There are four subfamilies. Only one, the Aristaeinae Alcock, 1901, characterized b a pronounced tubercle on the eyestalk and the cervical sulcus reaching dorsal midline o carapace, is represented in British Columbia waters. Most commercial shrimps in tropica regions belong to the subfamily Penaeinae Burkenroad, 1934 (genera *Penaeus* Fabricius 1798; *Metapenaeus* Wood-Mason 1891). The Aristaeinae are separated again into two categories, termed "series," one of which, Benthesicymae Bouvier, 1908, is relevant to th present work. The reliable diagnostic character of this series is that the distal, filamentou portion of upper or inner antennular flagellum is well developed; other, less dependabl characters are: tip of telson more or less blunt; and long antennal flagellum of two differen elements, separated by a portion forming an inflexion, or kink. Two species of *Bentheogennema,* one of the four genera in the series, occur off the west coast of Canada. To th south, and in the western Pacific, there are species of another closely related genus, *Gennadu* Bate, 1881. The two genera may be separated by the absence of podobranchs on the firs three pereiopods, a character of *Gennadus.* For identification of species of *Gennadus,* however it is necessary to consult keys based on characters of the thelycum and petasma (48, 12).

Genus *Bentheogennema* Burkenroad, 1936

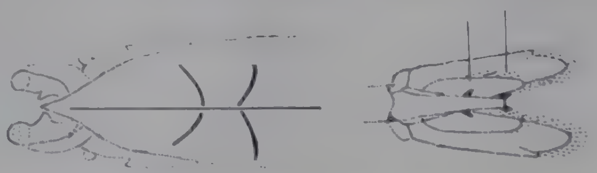
Eye well developed; stalk long, compressed, bent, with prominent tubercle. Podobranch on second maxilliped to third pereiopod, inclusive. Arthropod of first maxilliped large an plumose, or rudimentary. Dorsal carina on only sixth abdominal somite. Telson, truncate tip, with one or more pairs of movable lateral spines.

The above generic diagnosis includes changes required with respect to the characte of the arthrobranch on the first maxilliped and number of lateral spines on the telson following study of *B. burkenroadi* and *B. borealis* by Krygier and Wasmer (162). The genu has five known species (162).

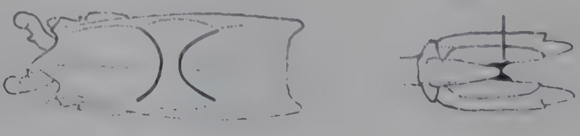
In this Bulletin, species of the genus are called "blunt-tailed" shrimps because of th short, truncated telson. This key is modified from Wasmer (273).

Key to species of genus *Bentheogennema*

1 Cervical and post cervical sulci fairly widely separated on dorsal midline of carapace and not interrupting median carina; 2 pairs of movable spines on telson .... Northern blunt-tailed shrimp, *B. borealis* (p. 41

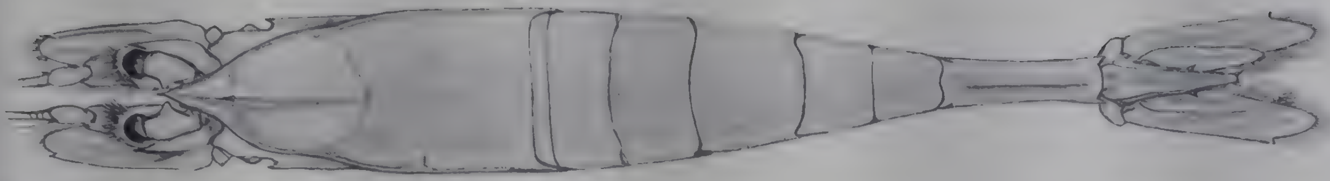


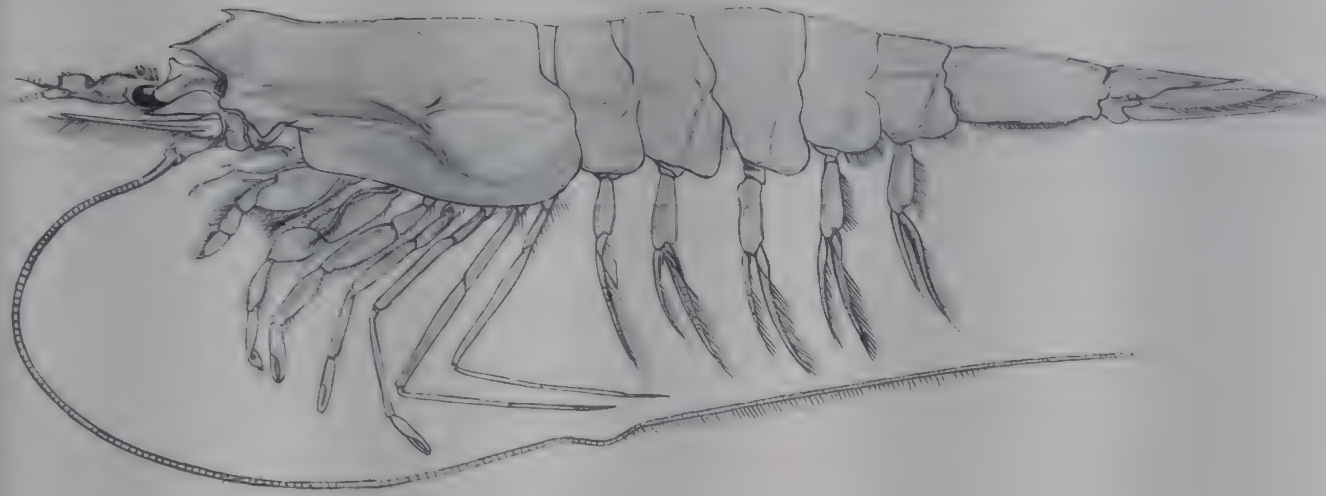
Cervical and postcervical sulci approaching each other closely on dorsal midline and interrupting median carina; 1 pair of movable spines on telson .... Burkenroad's blunt-tailed shrimp, *B. burkenroadi* (p. 4



NORTHERN BLUNT-TAILED SHRIMP

Bentheogennema borealis (Rathbun, 1902)





Description Body slender to moderately stout, little compressed. Shell membranous, surface smooth. Rostrum short, about 0.2 carapace length, extending beyond tubercle on eyestalk, as triangular extension of frontal region, $\frac{1}{0}$, fringe of setae from dorsal spine to acute tip. Carapace spines and carinae: suborbital moderate, rounded; antennal low on frontal margin, as acute angle; branchiostegal strong, extending beyond margin of anterolateral sinus supported by carina; median dorsal carina extending undivided from rostrum nearly to posterior margin; cervical and postcervical grooves fairly widely separated in midline, each extending to meet laterally antennal and branchial carinae; antennal carina extending from suborbital to hepatic region joining hepatic carina, then branchial carina, latter arching toward posterior margin of carapace; posthepatic carina extending dorsoventrally from longitudinal hepatic carina toward ventral margin of carapace, and continuing posteriorly; carina from branchiostegal spine to post hepatic carina. Eye small, cornea well developed, stalk depressed and bent, with pronounced tubercle on inner margin. Antennule: peduncle long, stout, third segment shorter than second, setae on distal margin of first; stylocerite short, wide base, swollen, tip acute; lengths of flagella unavailable. Antenna: scale longer than telson, moderately wide, lamella exceeds spine; basicerite rounded upper and lower lateral lobes; peduncle short; flagellum total length unavailable, proximal and distal elements with setae as in *B. burkenroadi,* and divided by segments forming kink (similar to Fig. 10). Second maxilliped: moderately long, flattened, especially merus; latter and carpus spinose and setiferous; propodus and dactylus spinose, latter with single terminal spine; exopod; epipod with podobranch. Third maxilliped: longer than second, flattened, broad, setose; dactylus flattened and twisted; exopod; epipod with podobranch. Pereiopods: I–III, each chelate, each epipod with podobranch, each setiferous; I about as long as third

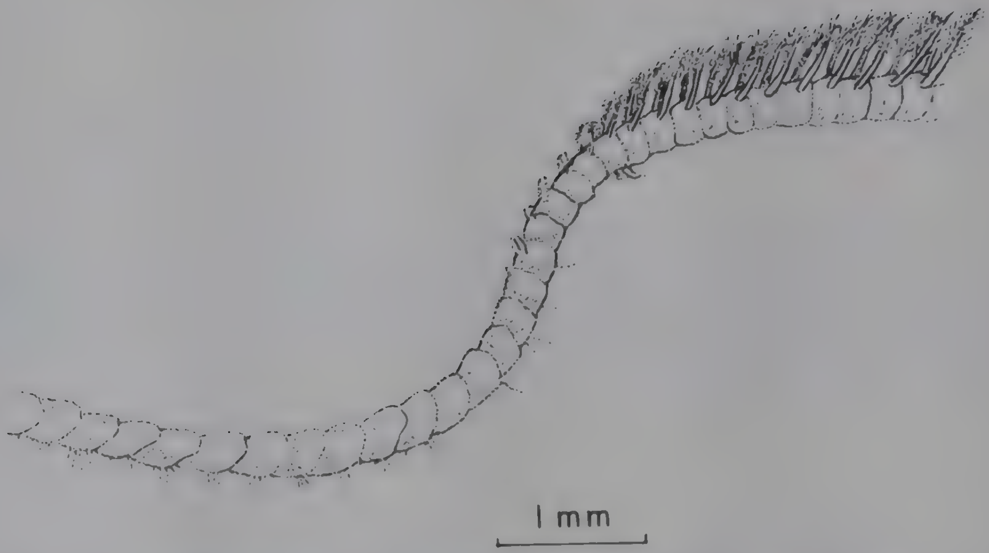


FIG. 10. Antennal flagellum of *Sergia robustus* (S. I. Smith, 1882), showing kink that separates proximal and distal elements of flagellum (after Foxton, 1969).

maxilliped, narrower; II longer than I, narrower, more slender; III longer than II, slender IV longer than III, slender; dactylus about 0.7 propodus length, tip acute; V shorter tha IV, more slender; dactylus about 0.75 propodus length, tip acute. Abdomen: pleuron c first somite with lateral carina; short lateral sulcus on pleuron of second, also with curve sulcus extending from midlateral region to, or near, ventral margin; similar sulci on eac of third and fourth, also on latter, wide, curved sulcus extending from near dorsal surfac to articular knob; fifth, lateral sulcus between articular knobs, also short sulcus obliqu toward dorsal margin; sixth, short carina across anterior dorsolateral sector, median dorsa carina almost as long as segment, carina from articular knob along anterolateral margi curving toward and along ventral margin, posteroventral angle obtuse; telson narrow tapering to truncate tip, 1 pair movable posterolateral spines, also 1 pair movable latera spines, wide median dorsal sulcus; outer uropod longer than inner, both exceed telso considerably. Petasma and thelycum have been described and illustrated (219, 4).

Color Eyes light brown with a speck of black pigment adjacent to cornea on oute margin of stalk (217).

Distinctions Distinguished by presence of podobranchs on epipods of pereiopods I–III telson normally with pair of distolateral spines, and pair of lateral spines; cervical an postcervical sulci fairly widely separated on dorsal midline of carapace, and not interruptin median carina; flattened and twisted dactylus of third maxilliped; tip of rostrum normall extending beyond tubercle on eyestalk.

Maximum lengths Males: carapace 15.3 mm, total about 58 mm; females: carapac 19.6 mm, total 64 mm.

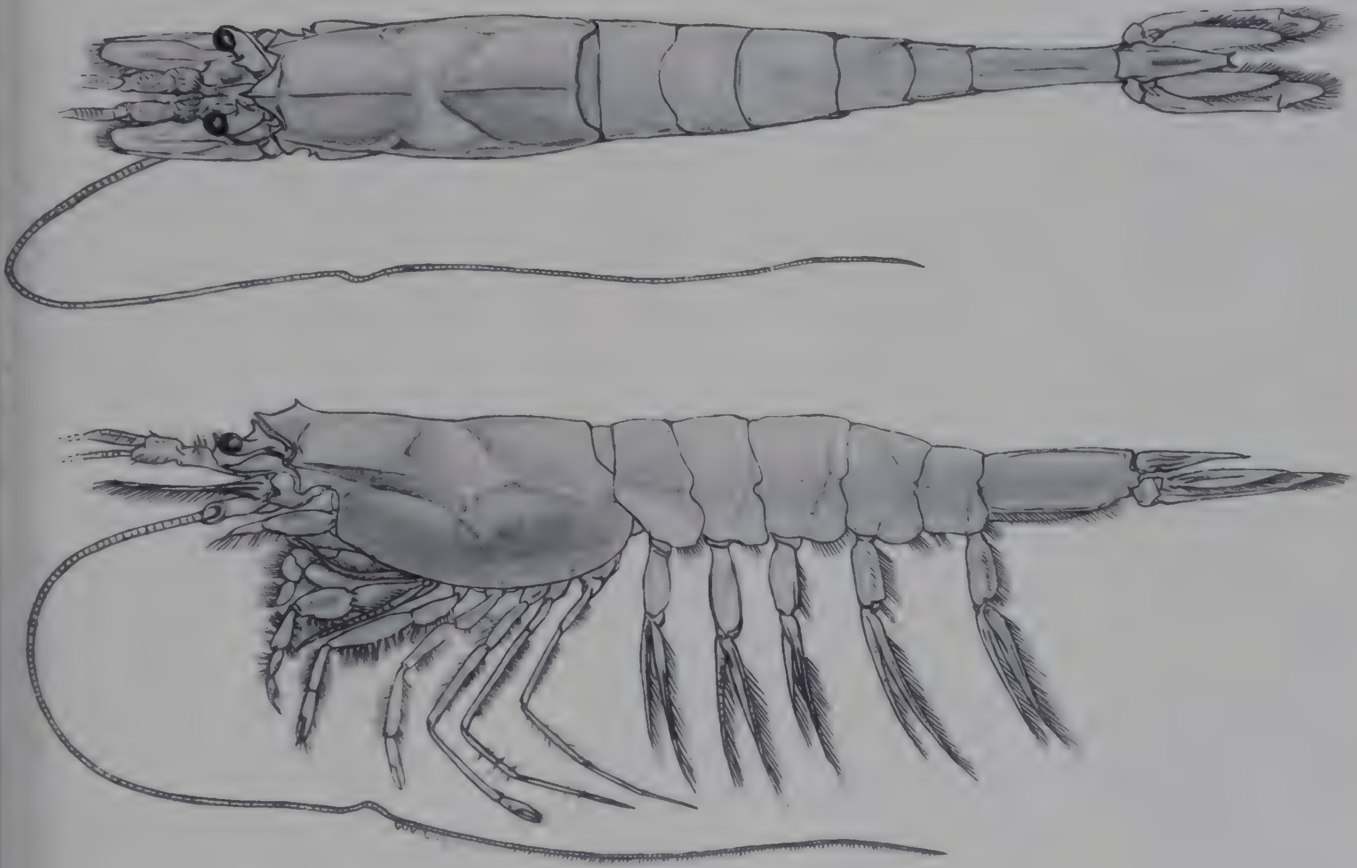
Range Bering Sea east of Kamchatka and north of Rat Islands, Aleutian Island (219) to south Coronodo Island, Baja California (232); 200–1500 m (205, 200).

The first known capture off the west coast of Canada was by *G. B. Reed*, 59 km southwes of Estevan Point (48.585′N, 127.03′W) Sept. 12, 1968.

Biology and economics *B. borealis* is said to be a typical bathypelagic species (200) living mainly below 700 m in the temperate North Pacific Ocean, but further north i subarctic waters, it is relatively abundant in the mesopelagic zone. Daytime trawling Ma 31, 1972, with a large Engel midwater trawl off Cape Flattery at 500 m and more belo the surface, in maximum depths, 1830–2560 m, yielded 53 specimens (18 ♂, 35 ♀): respectiv carapace lengths of males and females were 11.2–15.3 mm and 10.4–19.6 mm. The specie undergoes relatively little diel migration in Japanese waters (4), and a predator is the blu white dolphin, *Stenella caeruleoalba* (Meyen) (193). Whole bodies of *B. borealis* have, b dry weight, a higher carbon content (64.3%) and lower protein (37.3%) and ash (4.4%) contents than those of other epipelagic and upper mesopelagic species, for the respective constituents (40.3–47.9%, 58.1–71.9%, and 7.4–12.9%) (200). Lipid or fat content (62.4% dry weight) (92) is one of the highest among pelagic shrimps, but vitamin A is lacking (92).

BURKENROAD'S BLUNT-TAILED SHRIMP

Bentheogennema burkenroadi Krygier and Wasmer, 1975



Description Body slender, somewhat compressed. Shell thin, membranous, surface smooth. Rostrum short, 0.15–0.2 carapace length, to tubercle on eyestalk, as triangular extension of frontal region, $\frac{1}{0}$, fringe of setae from dorsal spine to acute tip. Carapace spines and carinae: suborbital moderate, rounded; antennal low on frontal margin, as acute angle or spine; branchiostegal weak, extending beyond margin of anterolateral sinus; median dorsal carina extends from rostrum almost to posterior margin, with or without minute tubercle posterior to dorsal spine, and absent between cervical and postcervical sulci, these 2 transverse sulci almost converge on median dorsal line, and meet laterally antennal and branchial carinae; antennal carina extends from antennal obliquely to hepatic region, joining branchial carina, latter arching toward posterior margin of carapace; posthepatic carin extending dorsoventrally from hepatic carina towards ventral margin of carapace; hepati sulcus continuous from branchiostegal spine toward ventral margin. Eye small, cornea we developed, stalk depressed, bent, pronounced tubercle on inner margin. Antennule: peduncl long, stout, second segment shorter than first and third, setae on distal margin of first stylocerite very short, wide base, tip acute; lengths of flagella unavailable. Antenna: scal longer than telson, moderately wide, lamella exceeds spine; basicerite, rounded upper, lowe moderate lateral lobes; peduncle short; flagellum very long; proximal section rigid, bearin short simple setae, separated by kink (see lateral view above) from distal section latte with paired arched plumose setae (similar to Fig. 10) with small plumose setae perpendicular to flagellum, spaced irregularly between bases of some arched pairs. Second maxilliped: short, flattened, especially merus; latter and carpus spinose and setiferous; propodu and dactylus spinose, latter, single terminal spine; exopod; epipod with podobranch. Thir maxilliped: longer than second, all segments greatly flattened, setiferous; dactylus, stron terminal spine; exopod; epipod with podobranch. Pereiopods: I–III, each chelate, each setiferous, each epipod with podobranch; I about as long as third maxilliped, narrower II about as long as I, narrower; III longer than II, slender; IV longer than III, very slender dactylus about 0.75 propodus length, tip acute; V about as long as IV, as slender; dactylu about 0.8 propodus length, tip acute. Abdomen: first somite, oblique lateral carina; pleura of second to fifth, each with oblique lateral carina extending from midlateral to or nea ventral margin; oblique lateral carina on fourth, from near median dorsal line to abou articular knob; fifth, oblique lateral carina between articular knobs; sixth, short carina extending across anterior dorsolateral sector, median dorsal carina almost as long as somite carina along ventral margin, posteroventral angle obtuse; telson narrow, tapering slightly to truncate tip, wide median dorsal sulcus, 1 pair posterolateral spines, rarely 1 pair movable dorsolateral spines; outer uropod longer than inner, both exceed telson considerably. Petasma, thelycum, and appendix masculina are described in detail and illustrated (162).

Remarks M. D. Burkenroad, American carcinologist, made basic contributions to the taxonomy of penaeidean shrimps.

Color Varying from deep red over entire body to medium red on cephalothorax and lighter on abdomen; black pigment fleck on distolateral edge of eyestalk adjacent to cornea; small flecks of purple often on carpus and propodus of third maxilliped and pereiopods I and II, on carpus of pereiopod III, and on ventral surface of abdominal somites just anterior to lateral edge of base of each pleopod (162).

Distinctions Distinguished by presence of podobranchs on epipods of pereiopods I–III; telson normally with pair of movable distolateral spines; cervical and postcervical sulci almost meeting in dorsal midline of carapace, and interrupting median carina; rostrum not normally extending beyond tubercle on eyestalk.

Maximum lengths Males: carapace 18.0 mm (162), total about 59 mm; females: carapace 20.0 mm (162), total about 66 mm.

Range Northeastern Pacific Ocean, 52–34° N, east of 142° W; surface to 1000 m (162). The first known capture off the British Columbia coast was by the research vessel *Endeavour,* about 260 km SW by W from Estevan Point (49.0′N, 130.04′W) Mar. 18, 1969 (Trans-PAC-1K-1) (15, 273).

Biology and economics Biological information accompanied the original species description (162), and is summarized here. Most known records of the species are from the Oregon and California coasts. Depth distribution is generally below 500 m by day and below 100 m at night. Females and males mature at carapace lengths 12 mm and 11 mm, respectively. Spawning occurs from November through February; egg and larval stages are estimated to last 3-5 mo; and from April through June, young shrimps measure 6-7 mm carapace length. After a further 12 mo maturity is reached, and spawning commences 5-6 mo later. Apparently adults live a year or two after first spawning.

Family SERGESTIDAE Dana, 1852

Carapace moderately compressed. Rostrum shorter than eyestalks, small, sometimes rudimentary. Lower or inner antennular flagellum of male modified as prehensile organ. First maxilliped with well-developed epipod and exopod. Third maxilliped and all pereiopods without exopods. Fourth and fifth pereiopods reduced or absent. Gills few. Petasma always symmetrical. No thelycum, but sternite between third pereiopods, sometimes also fourth pereiopods, and coxa of third pereiopods in females modified as sperm receptacle (273).

Yaldwyn (291) in his review of *Sergestes* s.l. concluded that its separation into two subgenera, *Sergestes* s.s. and *Sergia*, was supported by available evidence. His diagnoses of the subgenera are quoted below.

Subgenus *Sergestes* s.s. Milne-Edwards, 1830

Species of *Sergestes* s.l. with specialized luminescent modifications of the gastrohepatic gland (organs of Pesta) but without dermal photophores. Supraorbital and hepatic spines may be present or absent in adult. Ovary confined to cephalothorax. Color in life due to red subcuticular chromatophores mainly concentrated on the anterior part of the body. Twenty-six known species (200).

Subgenus *Sergia* Stimpson, 1860

Species of *Sergestes* s.l. without specialized luminescent modifications of the gastrohepatic gland (organs of Pesta). With or without dermal photophores, which, when present, may or may not have cuticular lenses. Supraorbital and hepatic spines absent in adult (secondary prominences may sometimes be present). Ovary may extend into abdomen. Adult with red cuticular pigment distributed over entire body and appendages. Twenty-seven known species (200).

Subsequent authors (190, 273, 1) have recognized the two subgenera. More recently, however, Omori (200) elevated the subgenera to full generic status, as *Sergestes* and *Sergia*. Through reexamination of earlier larval descriptions, he was able to indicate that two types of protozoeal larvae belonged to *Sergestes*, and the third to *Sergia*. Though knowledge of larvae of the group is incomplete, it appears that he has brought to light notable differences in larval morphology that parallel those in adults. Without contributing new information to the subject, the present author supports Omori's opinion that *Sergestes* Milne-Edwards, 1830 and *Sergia* Stimpson, 1860 are distinct genera. Yaldwyn's subgeneric diagnoses (291), quoted above, presumably will apply to the genera. However, the diagnosis of *Sergia* requires modification to accommodate semitransparent species such as *S. lucens* (Hansen, 1922) (200).

The family has world-wide distribution. Most species are pelagic and several occurring in the epipelagic zone are known to form dense concentrations (200). *Sergia lucens* supports a commercial fishery in Suruga Bay, Japan, with annual landings of 4000-7000 t (199). Bioluminescence has been reported in three genera, *Sergestes*, *Sergia*, and *Acetes* (83, 200). In temperate waters, species of the Sergestidae, living in epipelagic and mesopelagic zones, reach the spawning peak in summer (200), and pass through three types of larval stages — nauplius (Fig. 11A), protozoea, and zoea (Fig. 11B).

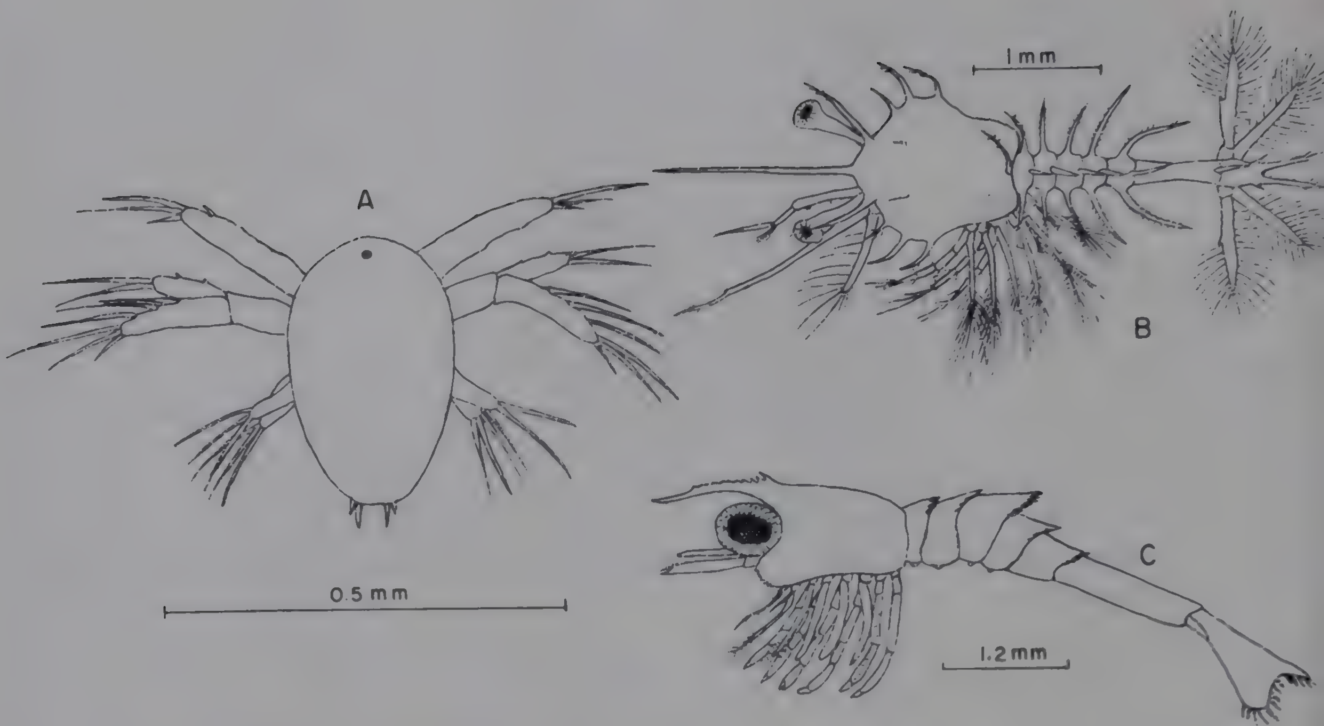
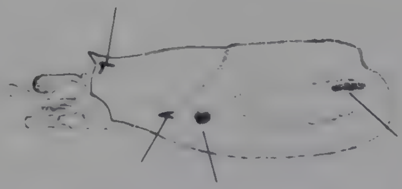


FIG. 11. Larvae of shrimps. (A) first nauplius of *Sergia lucens* (after Omori, 1974), (B) first zoea of *S lucens* (after Omori, 1969), (C) first zoea of *Pandalus platyceros* (after Price and Chew, 1972).

Each of the two genera, *Sergestes* and *Sergia*, is represented in British Columbia waters by one species, termed here a sergestid.

Key to species of Family SERGESTIDAE

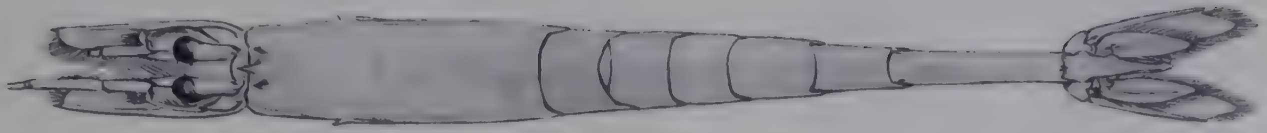


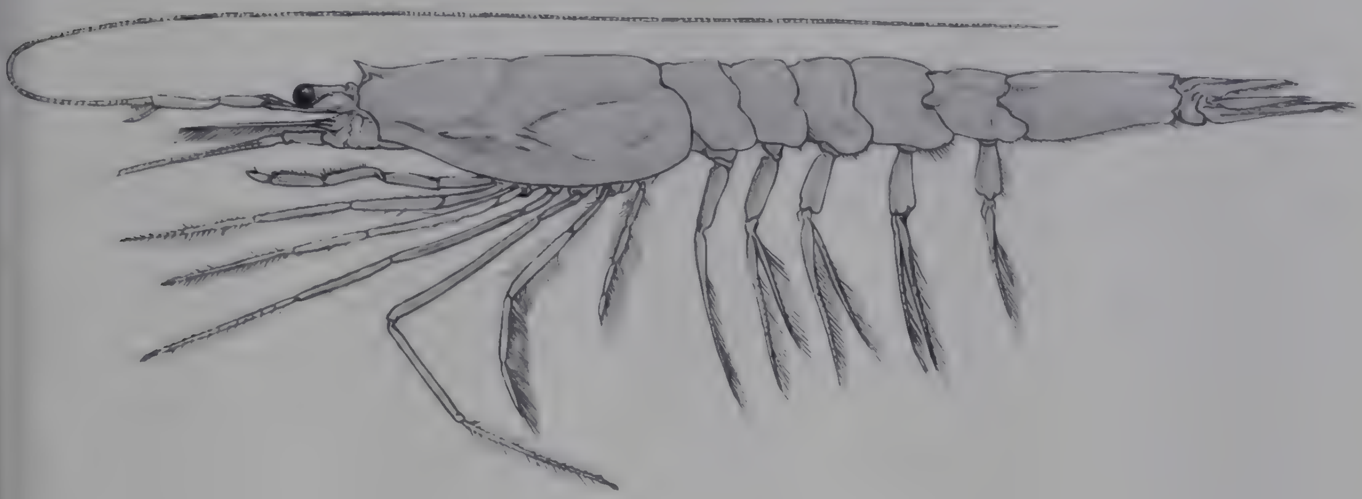
1 With supraorbital and hepatic spines; with organs of Pesta; color in life due to scattered red subcuticular chromatophores .... Pacific sergestid, *Sergestes similis* (p. 47

Lacking supraorbital and hepatic spines; without organs of Pesta or other luminescent organs; color in life due to red cuticular chromatophores distributed uniformly over entire shrimp .... Ocean sergestid, *Sergia tenuiremis* (p. 49

PACIFIC SERGESTID

Sergestes similis Hansen, 1903





Description Body slender, somewhat compressed. Shell thin, surface generally smooth. Rostrum short, less than 0.1 carapace length, obliquely erect, tip acute. Carapace spines and carinae: supraorbital moderate, at end of short carina; hepatic moderate, lying on slightly sinuous carina extending from antennal region to lower branchial region around middle of carapace; above end of latter, 2 carinae beginning in shape of wishbone, extending toward posterior margin of carapace; short oblique branch of carina above hepatic spine; cervical sulcus more distinct laterally; anterolateral margin concave in antennal region. Eye small, cornea well developed, stalk long. Antennule: peduncle very long, exceeding antennal scale, slender, second segment shorter than third, first longer than third; stylocerite very short; outer flagellum longer than body, inner shorter than second segment of peduncle in females, longer than third segment, modified as prehensile organ in males (Fig. 4A). Antenna: scale about as long as sixth somite, narrow, spine exceeds lamella; basicerite, upper lateral lobe with weak spine, lower rounded lobe; peduncle short; total length of flagellum unavailable. Second maxilliped: short, moderately stout; propodus and dactylus flattened; 3 distal segments setiferous. Third maxilliped: longer, more slender than second;

propodus and dactylus, setae on both margins, latter with about 8 short, tapering segment Pereiopods: I shorter than third maxilliped, slender; propodus and dactylus, setae on bot margins, latter very short, with 1 or 2 distal setae; II longer than I, as slender; propodu with setae, 10–12 segments; minutely chelate, tip with long setae; III longer than II, a slender; propodus with setae, about 10 segments, minutely chelate, tip with long setae IV shorter than III, as slender, setiferous; propodus tip rounded; dactylus lacking; V shorte than IV, more slender, setiferous; propodus tip rounded; dactylus lacking. Abdomen: firs to third somites, each with dorsoventral sulcus adjacent to posterolateral margin; thir also with dorsal transverse sulcus from articular knob; fourth, oblique sulci extending fro articular knob; fifth, arched lateral sulcus; sixth greatly compressed, faint lateral carin almost as long as somite; dorsal, median, posterior spine weak, posteroventral angle obtuse telson much shorter than uropods, narrow, tapering to acute tip, median dorsal sulcus lateral setae; tip of inner uropod not reaching distolateral spine on outer uropod. Detaile descriptions and illustrations of petasma and thelycum are available (99, 190). Five organ of Pesta present. Anterolateral pair most prominent (eventually opaque white in formalin) as spheroid body on each side, posterior to hepatic spine; lateral midgastric pair (exac location unknown to author); and posterolateral organ, a continuous fringe or bar, visibl below suprabranchial carina, adjacent to posterolateral margin of carapace. Terms fo separate organs from Foxton (300).

Color Viscera as visible under carapace, red tone, or dark mauve to black; orange-re spots scattered over carapace and abdomen, including telson and uropods, and basiopodite of pleopods; lateral line of spots above ventral margin of sixth somite; second and thir maxillipeds and pereiopods I–III with light red spots, IV and V with sparse spots o transparent; proximal segments of all pereiopods amber; antennal flagellum and oute antennular flagellum, pink to amber. Organs of Pesta: on each side of carapace posterio to hepatic spine, one of anterolateral pair is conspicuous, described by A. A. Denbigh a "a black dot surrounded by red"; fringe of posterolateral organ appears as black bar below suprabranchial carina, adjacent to posterolateral margin of carapace (Plate 1F). Photograph of *S. similis* in an aquarium by Omori (200) show fringe of posterolateral organ remain in horizontal plane whether shrimp swims horizontally or obliquely; accordingly, orientatio of fringe in Plate 1F is that expected for an animal with head up in a slightly oblique position.

Distinctions The Pacific sergestid is distinguished from *Sergia tenuiremus* by having both supraorbital and hepatic spines; organs of Pesta, one of which is prominent, posterior to hepatic spine, in freshly caught or preserved specimens; lacking a tubercle on inner margin of eyestalk.

Maximum lengths Males: carapace 18.4 mm, total 61 mm; females: carapace 17.8 mm, total 57 mm.

Range North Pacific Ocean; east coast of Honshu Island to southwestern Bering Sea, Gulf of Alaska (200) to Gulf of California (219); surface to 1200 m (201).

The first known record of the species in British Columbia waters was by the author (55) of specimens captured by a shrimp trawl, south of Victoria, B.C., at 110 m, Aug. 8, 1954.

Biology and economics This shrimp is fairly common on the continental shelf and slope off the west coast of Vancouver Island, and in the deeper waters of Dixon Entrance. It inhabits sonic scattering layers in the Strait of Georgia (55) but appears to be less abundant than another pelagic shrimp, *Pasiphaea pacifica.* Around Japan, *S. similis* occurs by day at 150–300 m below the surface, and from the surface to 100 m at night (200). Off Oregon (205), day and night depth ranges were 150–500 m and surface to 150 m, respectively. There also, it was more abundant inshore (46 km) in winter and more abundant offshore (beyond

120 km) in summer (205). Across the North Pacific the species occurred at temperatures 3–15°C, and salinities 32.6–34.3‰ (201).

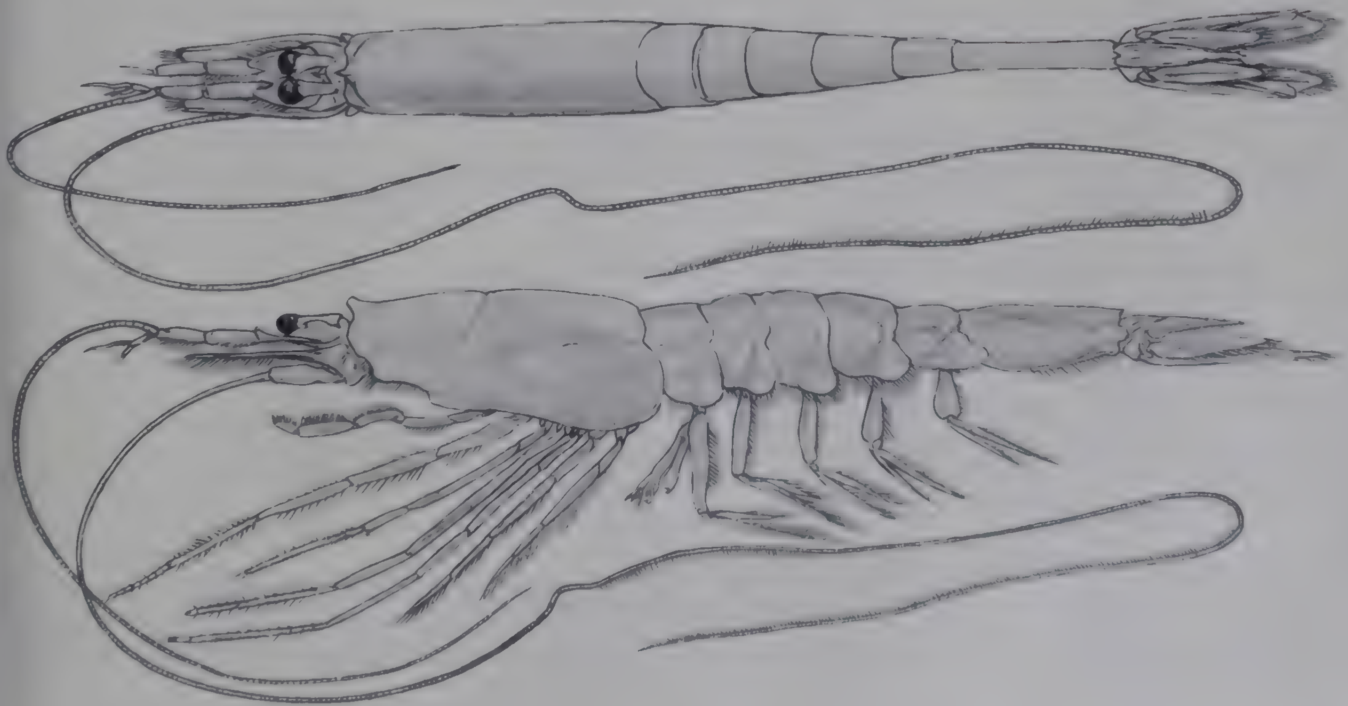
Structure of reproductive organs is known (99). Off Oregon, maturity of both sexes is attained at about 11 mm carapace length, after a year of life (206). There, although spawning reportedly occurs throughout the year (206), peaks of activity are seen in spring and summer. Freshly spawned eggs measured 0.23 × 0.33 mm (206). In Santa Barbara Channel, the species apparently is not mature until the second year when, after spawning, it dies (99). Data from Oregon (206) suggest that *S. similis* is an annual species, dying shortly after spawning.

The larger more abundant copepod species and, to a lesser extent, euphausiids and other organisms, are eaten by the shrimp, which may feed more actively at night (149). Reported predators are albacore, *Thunnus alalunga* (Bonnaterre 1788) (149); yellow tail rockfish, *Sebastes flavidus* (Ayres, 1862) (201); sei whale, *Balaenoptera borealis* Lesson, 1828 (201); and fin whale, *B. physalus* (Linnaeus, 1758) (201). Carapace length–total length, and carapace length–weight relationships are known (201). Constituents of the whole body of *S. similis* by dry weight are carbon 47.2%, protein 61.3%, ash 12.9%, and lipid or fat 16.1% (92). Vitamin A content (3.0 μg/g wet weight) is higher than in most pelagic shrimps (92). *(See Bentheogennema borealis* p. 41).

S. similis is very abundant in North Pacific sei and fin whale feeding areas, bounded by 50° and 40°N, 132° and 143°W, and 157° and 174°W (201). From sunset to sunrise, shrimp occur in dense concentrations near the surface, estimated from whale feeding data at 100–4500 individuals per cubic meter. These stocks of *S. similis* may have direct commercial value in the future (201).

OCEAN SERGESTID

Sergia tenuiremis (Krøyer, 1855)



Description Body slender, carapace greatly compressed, abdominal somites, notabl sixth, more so. Shell membranous, surface generally smooth. Rostrum short, less tha 0.1 carapace length, obliquely erect, barely projecting beyond frontal margin, tip obtuse Carapace carinae and sulci: lateral carina extending from branchiostegal to hepatic region separated from latter by short space, suprabranchial extending with ventral deflection almos to posterior margin; cervical sulcus conspicuous; suprabranchial carina sometimes branching ventrally and posteriorly above ventral margin of carapace; anterolateral margin with setae convex adjacent to antenna, concave below. Eye moderately large, cornea well developed tubercle on inner margin of stalk. Antennule: peduncle exceeding antennal scale, stout third segment subequal to second, first with dorsal distal tubercle; stylocerite very short outer flagellum over twice carapace length, length of inner flagellum in females unavailable in males, longer than any segment of peduncle, modified as prehensile organ. Antenna scale as long as sixth somite, narrow, outer margin slightly concave, spine exceeds lamella basicerite, upper rounded lateral lobe; peduncle short; flagellum very long; proximal section rigid, separated by kink (see lateral view above) from distal section with paired arched plumose setae (similar to Fig. 10). Second maxilliped: short, moderately stout, sinuous setiferous. Third maxilliped: longer, proximal segments stouter than second; propodus and dactylus, setae on both margins, latter with about 8 short, tapering segments. Pereiopods: I shorter than third maxilliped, slender; propodus and dactylus, setae on both margins latter very short, with 1 or 2 distal setae; II longer than I, as slender; propodus with setae about 13 segments; minutely chelate; III slightly longer than II, as slender; propodus with setae, about 12 segments; minutely chelate; IV shorter than III, as slender, setiferous; propodus, tip blunt; dactylus lacking; V shorter than IV, as slender, setiferous; propodus tip blunt; dactylus lacking. Abdomen: on first somite, oblique lateral carina; on second short lateral carina, also faint transverse sulcus; on third, dorsoventral carina, roughly paralleling posterolateral margin, also transverse sulcus; fourth with V-shaped sulcus, its angle at articular knob; on fifth, arched lateral carina, oblique sulcus extending ventrad; sixth, median, dorsal, posterior spine with slight carina, lateral carina arching gently toward obtuse posteroventral angle, and carina along ventral margin; telson much shorter than uropods, narrow, tapering to acute tip, dorsal median sulcus, 2 or 3 pairs dorsal spines lateral setae; tip of inner uropod not reaching to distolateral spine on outer uropod.

Color More or less uniform vermillion over abdomen including pleopods, posterior part of carapace, and antennule and antenna (color of flagella unavailable); darker red over most of telson and uropods, third maxilliped and pereiopods; second maxilliped mauve; most of carapace anterior to cephalic sulcus deep purple; eyestalk transparent.

Distinctions Separated from *Sergestes similis* by lack of supraorbital and hepatic spines; presence of tubercle on inner margin of eyestalk; and, if present and intact, long antennal flagellum with kink.

Maximum lengths Males: carapace 21.0 mm, total about 63 mm; females: carapace 27.4 mm, total 75 mm.

Range Pacific Ocean, west coast of Vancouver Island to Hawaiian Islands (220); northeast of New Zealand (26); Indian Ocean; Atlantic Ocean (1); 570–1000 m and likely deeper (95).

The first and only known Canadian capture was by *G. B. Reed* 102 km southwest of Amphitrite Point (48.135°N, 126.24°W), May 30, 1972.

Biology and economics This species is apparently uncommon off the British Columbia coast and elsewhere in the Pacific Ocean (273). Near the Canary Islands, it is a deep mesopelagic species that migrates at night to the upper mesopelagic zone (95). The internal structure of the eye is known (277).

SECTION CARIDEA

Abdomen generally with shrimp bend at third somite. Pleuron of second somite overlapping pleura of first and second somites. Mandibular palp, if present, straight. First maxilliped with lobe at base of exopod, endopod short. Endopod of third maxilliped with four to six segments (rarely seven). Third pereiopod never chelate. First pair of pleopods of male without petasma. Appendix interna present on pleopods. Eggs of female carried attached to pleopods (21, 72). The name Caridea is derived from the Latin word "caris," for shrimp.

The section was divided into nine superfamilies (131). As these categories are not described in the present work, interested readers should also consult more recent papers (261, 72). There are more than 1600 species living in the sea and in fresh water. Eggs carried by females generally hatch in the zoeal stage (Fig. 11C), but sometimes may be termed a protozoea. The caridean larva passes through the mauplius stage while still in the egg (106).

Eighty-one species, representing six families, are known from the Pacific coast of Canada. All are marine.

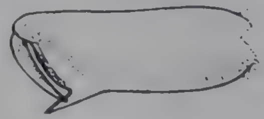
Key to Families of CARIDEA

1 Exopods present on all pereiopods 2

Exopods not present on pereiopods 3

2 First 2 pereiopods longer, stouter, than others; rostrum proper, or epigastric spine short .... Pasiphaeidae (p. 52)

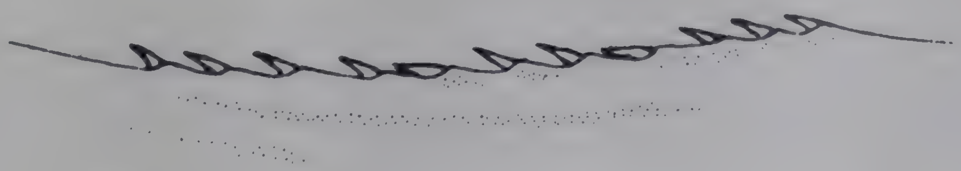
First 2 pereiopods shorter than others, not markedly stouter; rostrum prominent with dorsal spines .... Oplophoridae (p. 59)



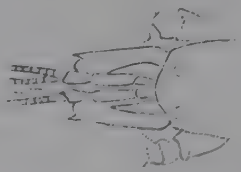
3 First pereiopod subchelate; second pereiopod chelate, with undivided carpus .... Crangonidae (p. 73)

First pereiopod not subchelate; second pereiopod chelate, with subdivided carpus 4

4 Carpus of second pereiopod subdivided into more than 7 small segments; rostrum large, all or most dorsal spines movable .... Pandalidae (p. 123)



Carpus of second pereiopod subdivided into 3–7 small segments; rostrum, if present, moderate size, without movable spines ....



5 Rostrum absent; eyes covered or partly hooded by carapace........ Alpheidae (p. 14

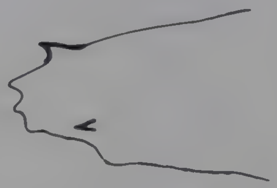
Rostrum present, eyes not covered by carapace .... Hippolytidae (p. 154

Family PASIPHAEIDAE Dana, 1852

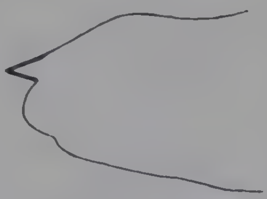
Rostrum short or absent; in latter case, represented by postfrontal or gastric spin Carapace with or without branchiostegal spine. Mandible without molar process and wit or without a palp. Third maxilliped with exopod, and with or without epipod. All pereiopod with exopods and without epipods. First two pairs much longer and stouter than last thre pairs, chelate with elongate fingers, each with carpus undivided.

Two genera, *Pasiphaea* and *Paraphasiphae,* are represented in British Columbia waters.

Key to genera of Family PASIPHAEIDAE



1 Rostrum in form of a postfrontal, or epigastric, spine; carapace with branchiostegal spine .... *Pasiphaea* (p. 53



2 Rostrum arising from frontal margin of carapace; carapace without branchiostegal spine .... *Parapasiphae* (p. 57

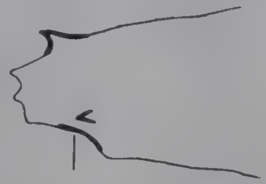
Genus *Pasiphaea* Savigny, 1816

Body strongly compressed. Rostrum consisting of postfrontal or epigastric spine. Orbi poorly defined. Carapace with branchiostegal spine. Mandible without palp. Third maxillipe without epipod. Fourth pereiopod shorter than fifth.

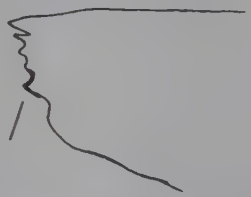
These shrimps are moderate to large in size. Species of the genus, about 30, occur in all oceans (49, 179, 293). Because living individuals of some species have transparent bodies, they are commonly termed "glass" shrimps (256). Also in this Bulletin "pasiphaeid" is used for members of the genus and family. All pasiphaeids appear to be free swimming throughout their lives, inhabiting mainly the epipelagic and mesopelagic zones. Ovigerous females carry relatively few large eggs, and larvae hatch at an advanced stage. There is an account of the biology of an Atlantic species *P. multidentata* (16). The generic name has its origin in Greek mythology. Pasiphaë was the wife of King Minos of Crete, and mother of the Minotaur.

Two species are known from the British Columbia coast.

Key to species of genus *Pasiphaea*



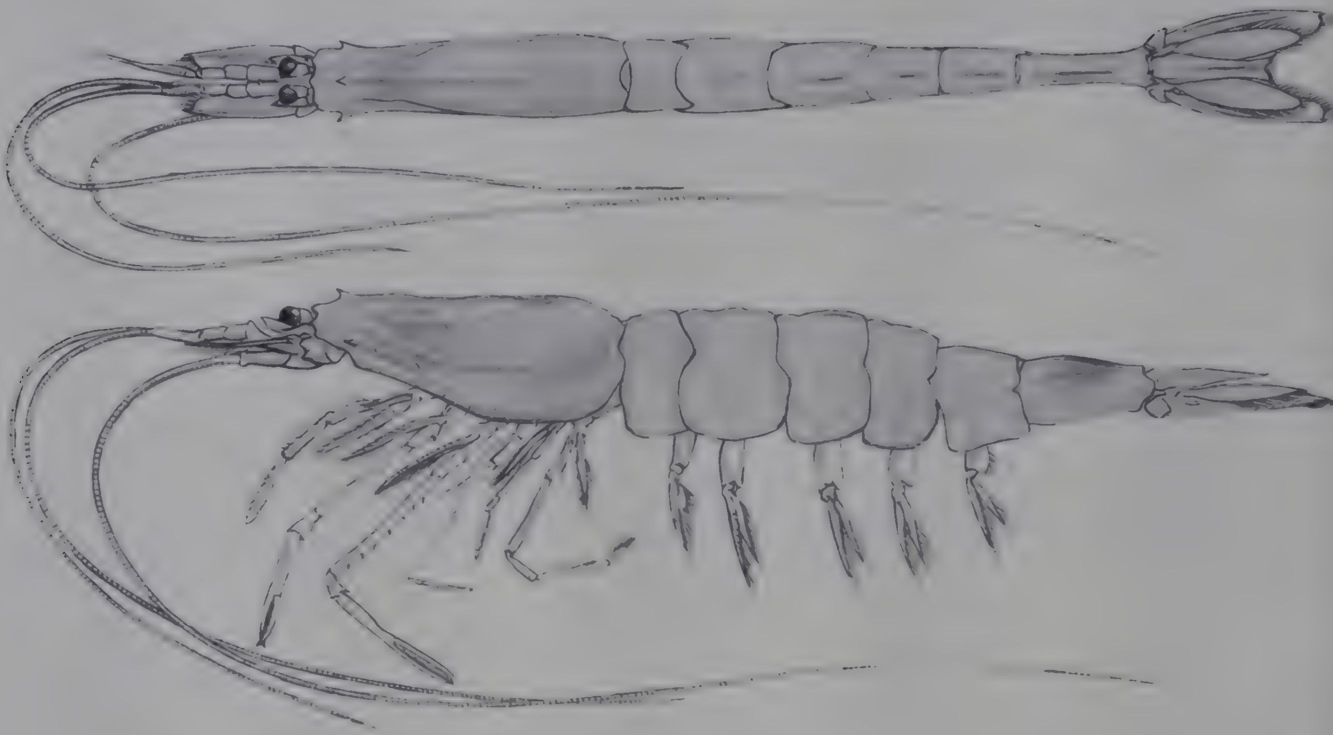
1 Branchiostegal spine above branchiostegal sinus, not reaching anterior margin of carapace; small to moderate in size; live specimens mainly transparent .... Glass shrimp, *P. pacifica* (p. 54)



2 Branchiostegal spine near or on anterior margin of carapace, extending beyond it; moderate to large; live specimens mainly crimson .... Crimson pasiphaeid, *P. tarda* (p. 56)

GLASS SHRIMP

Pasiphaea pacifica Rathbun, 1902



Description Body moderately deep, strongly compressed. Shell thin, smooth. Rostrum as postfrontal or epigastric spine, moderately long, directed anteriorly, thornlike, tip acute. Carapace: dorsal anterior margin narrow, rounded; distinct dorsal carina extending from gastric spine to near posterior margin; well-defined, curved carina on lateral surface, extending from near orbit across branchial region to near posterior margin, with short branch below extending to near base of pereiopod II; branchiostegal spine strong, above branchiostegal sinus, with supporting carina. Eye moderately large, cornea well developed. Antennule: peduncle long, second segment shorter and stouter than third; stylocerite long, knifelike; both flagella over twice length of carapace, outer somewhat longer. Antenna: scale long, tapering, outer margin convex, spine exceeding lamella; basicerite, upper lateral lobe, lower strong spine; peduncle moderately long, flagellum longer than body. Third maxilliped: moderately long, moderately stout; exopod. Pereiopods: all with long exopods; I longer than third maxilliped, moderately stout; merus, 0–4 spines; propodus, lower inner margin with 3 or 4 spinules; dactylus and fixed finger slender, scissorlike, both inner margins finely toothed, about 0.87 proximal propodus length; II longer than I, slightly stouter; ischium, 0 or 1 spine; merus, 8–11 spines; carpus, strong lower distal spine; dactylus and fixed finger slender, scissorlike, both inner margins finely toothed, almost as long as palm; III shorter than II, very slender; dactylus slender, about 0.15 propodus length; IV shorter than III, slender; dactylus flattened, tip rounded, about 0.2 propodus length; V longer than IV; slightly stouter; dactylus flattened, tip rounded, about 0.33 propodus length. Abdomen: second to sixth somites each with distinct median, dorsal carina; second to fourth somites, each with short, transverse sulcus; lateral surface of sixth with curved carina; telson slightly shorter than sixth, moderately wide, with median, dorsal sulcus, distal end deeply notched with fine spinules on inner margins, increasing in size posteriorly to large outer spinules; outer uropod longer than inner, both exceeding telson considerably.

Color Plate 3B represents maximum coloration on *P. pacifica.* Most transparent specimens have the following basic color pattern: conspicuous pinkish visceral mass in gastric region of carapace; pleopods and tail fan almost entirely red; red patch or irregular stripe on dorsal surfaces of third to sixth abdominal somites; red dots appear sparsely from lower branchial region to ventral margin of carapace; scattered small red patches on third maxilliped and pereiopods, more intense on chelae; antennular peduncle and flagella, and antennal flagellum faintly red; red along inner margin of antennal scale, and on distal end of antennal peduncle.

The coloration of *P. pacifica* was related to its occurrence in the epipelagic zone (205), i,e. partly red in contrast to "all red" species in the mesopelagic zone.

Distinctions Distinguished by the strongly compressed body, mainly transparent when alive; presence of thornlike epigastric spine; position of branchiostegal spine somewhat behind frontal margin, and above branchiostegal sinus of carapace.

Maximum lengths Males: carapace 25.7 mm, total 81 mm; females: carapace 21.5 mm, total 73 mm.

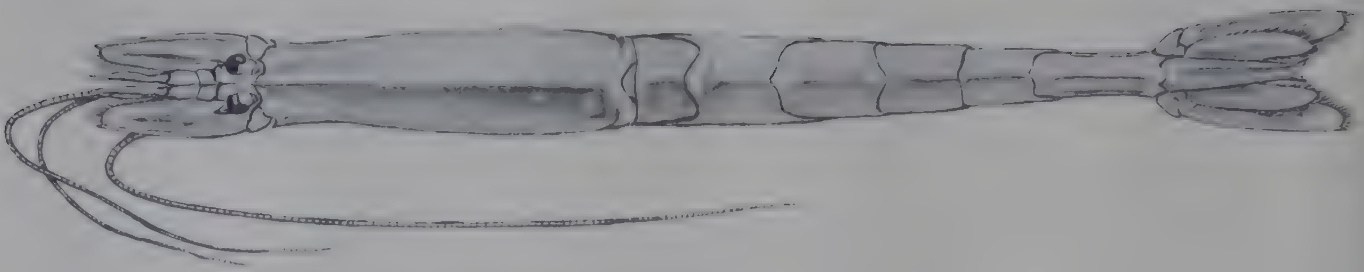
Range Unalaska to Gulf of California (219); Okhotsk Sea; 0–1076 m (265).

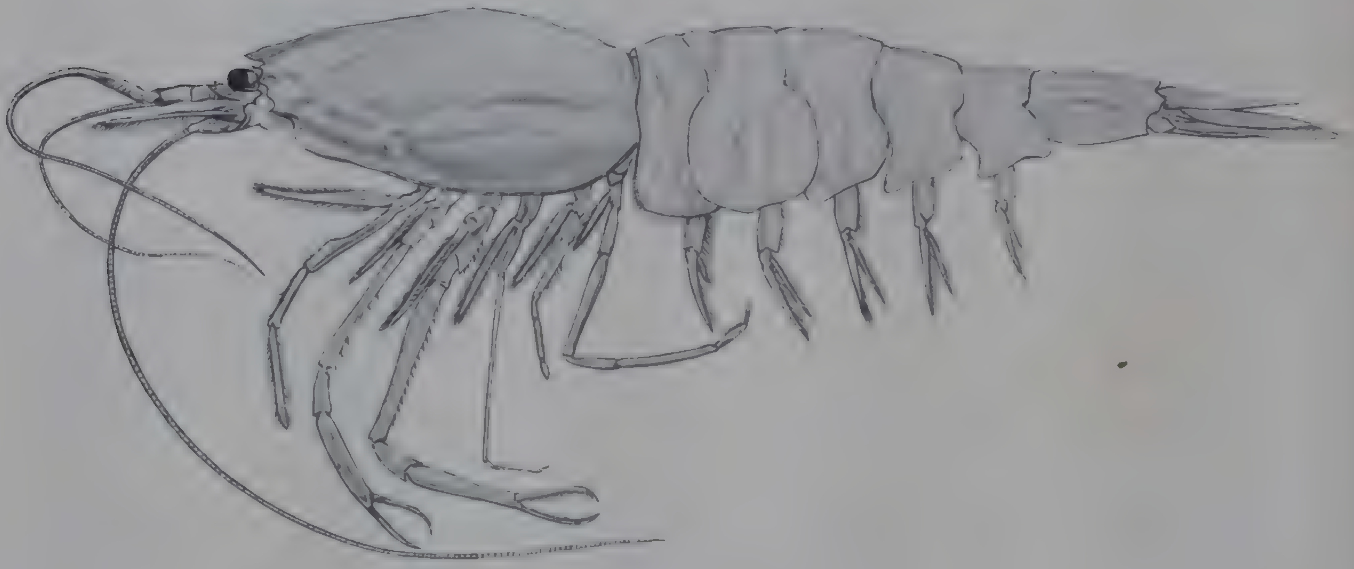
First taken in British Columbia waters by the *Albatross* Aug. 31, 1888, northwest of Cape Scott at 373 m (station 2861) (219).

Biology and economics The glass shrimp inhabits the epipelagic zone of all coastal areas of the province. In the Strait of Georgia it was captured in midwater trawls from 26 to 236 m below the surface, within temperature and salinity ranges 7.7–10.5°C and 24.9–31.0‰, respectively (152). Off the coast of Oregon, the species was caught in the upper 49 m at night, occurring even at the surface (205). The main food of *P. pacifica* consists of euphausiids (224). One known predator is the rockfish, *Sebastes flavidus* (208). Counts of eggs on 21 females were 18–54. One parasite is the isopod *Holophryxus alaskensis* (56), and another is a protistan of the family Ellobiopsidae, *Thalassomyces capillosus* (126, 289). The latter parasite, when in position on the carapace, may distort the normal shape of the epigastric spine (184). Another ellobiopsid, *Ellobiocystis caridarum,* is an epibiont, present on the mouth parts of the glass shrimp (289).

CRIMSON PASIPHAEID

Pasiphaea tarda Krøyer, 1845





Description Body deep, strongly compressed. Shell thin, smooth. Rostrum as postfrontal or epigastric spine, more or less bladelike ascending or descending, may extend beyond frontal margin, tip normally acute. Carapace: dorsal anterior margin narrow, rounded; distinct dorsal median carina extending from gastric spine to near posterior margin; main lateral carina extending from hepatic region posteriorly but disappears before reaching posterior margin, short oblique branch extending to ventral margin, adjacent to base of pereiopod II; obscured above, irregular carina deflected dorsally before reaching posterior margin; suborbital angle prominent, rounded; antennal spine as lobe; branchiostegal spine strong near or on frontal margin, with slight supporting carina. Eye small, cornea well developed. Antennule: peduncle long, third segment over twice length of second; stylocerite short, twisted; outer flagellum longer than carapace, with flattened proximal section, inner somewhat shorter. Antenna: scale longer than telson, convex on outer margin, spine exceeding lamella; basicerite, upper lateral lobe, lower strong spine; peduncle short; flagellum longer than body. Third maxilliped: long, moderately stout; long exopod. Pereiopods: all with exopods, from II latter decreasing in length posteriorly; I longer than third maxilliped, stout; merus, 2–8 (normally 7 or 8) spines at distal end, about 30 spinules along entire margin; carpus, 2 distal spinules; propodus, outer surface with wide sulcus, and about 10 spinules, unevenly spaced, inner surface with about 14 spinules; dactylus and fixed finger slender, scissorlike, both inner margins finely toothed, about 0.65 proximal propodus length; II longer than I, stouter; basis, 2–7 spines; ischium, 0 or 1 spine; merus, 14–21 spines and about 25 spinules along entire margin; propodus, inner surface with about 15 spinules, outer surface about 8 spinules, widely scattered; dactylus and fixed finger slender, scissorlike, both inner margins finely toothed, about 0.5 entire propodus length; III shorter than II, very slender; dactylus spiniform, about 0.37 propodus length; IV shorter than III, slender; dactylus flattened, about 0.56 propodus length; V longer than IV, moderately stout; dactylus flattened, about 0.36 propodus length. Abdomen: first to sixth somites each with distinct median dorsal carina; sixth with curved lateral carina; telson slightly longer than sixth, moderately wide, dorsal surface sulcated, distal end notched, with fine spinules on inner margins; outer uropod longer than inner, both exceeding telson.

Color Entire animal crimson, except dorsal margin of epigastric spine, anterolatal margin of carapace, basicerite, peduncle, and part of scale of antenna, as well as stylocerite of antennule, which are transparent (Plate 3D). *P. tarda* is an "all red" species as other deep mesopelagic pasiphaeids (95).

Distinctions Distinguished by strongly compressed body, normally crimson over most of surface when freshly caught; presence of knifelike postfrontal or epigastric spine; position of branchiostegal spine near or on frontal margin of carapace; 2–7 spines on basis of pereiopod II.

Maximum lengths Males: carapace 54.6 mm, total 152 mm; females: carapace 75 m, total 215 mm (243).

Range Unalaska to Oregon (219, 273); also off Ecuador (88); North Atlantic Ocean from Greenland and Jan Mayen to Bay of Biscay (237); south of Canary Islands (183); and on American coast south to South Carolina (237); also off Angola (80); 251–2400 m.

First taken in British Columbia waters by *G. B. Reed* June 15, 1964, 35 miles S by W of Cape St. James (51°26′N, 131°09′W), in a midwater trawl, 640–730 m below the surface.

Biology and economics Several specimens of *P. tarda* were caught off the west coast of Vancouver Island in May 1972 by midwater and bottom trawling. Nothing is known of the biology in eastern Pacific waters. Remains of euphausiids were found in stomachs of specimens collected near Newfoundland and Labrador and in the Canadian eastern arctic (247). Egg counts on 2 females from Korsfjorden, Norway, were 115 and 120 (182). The parasitic protozoan, *Thalassomyces capillosus,* infests the crimson pasiphaeid and may cause deformation of the postfrontal spine (237). Larval stages are known (86, 287).

Genus *Parapasiphae* Smith, 1884

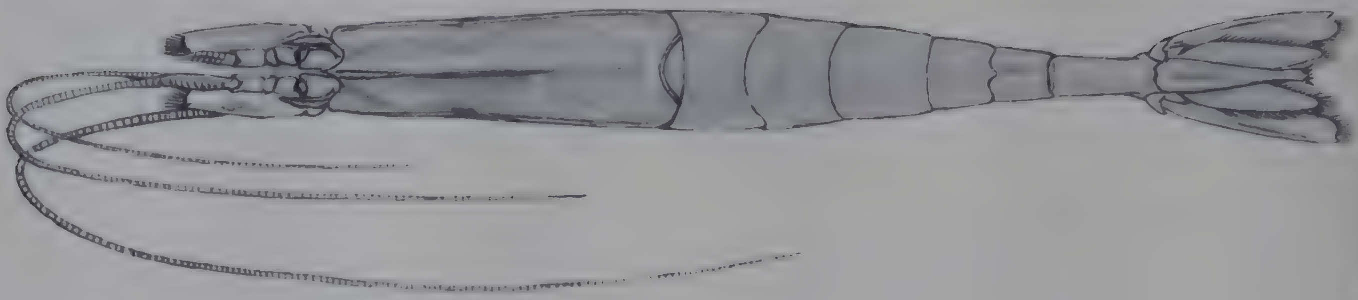
Body moderately compressed. Normal rostrum present, short, arising from frontal margin of carapace. Mandible with two-jointed palp in mature forms. Third maxilliped with exopod and epipod. All pereiopods with exopods, without epipods. First and second pereiopods similar, ending in elongate chelipeds with long, slender fingers, and longer and stouter than other pereiopods. Fourth pereiopod shorter than fifth.

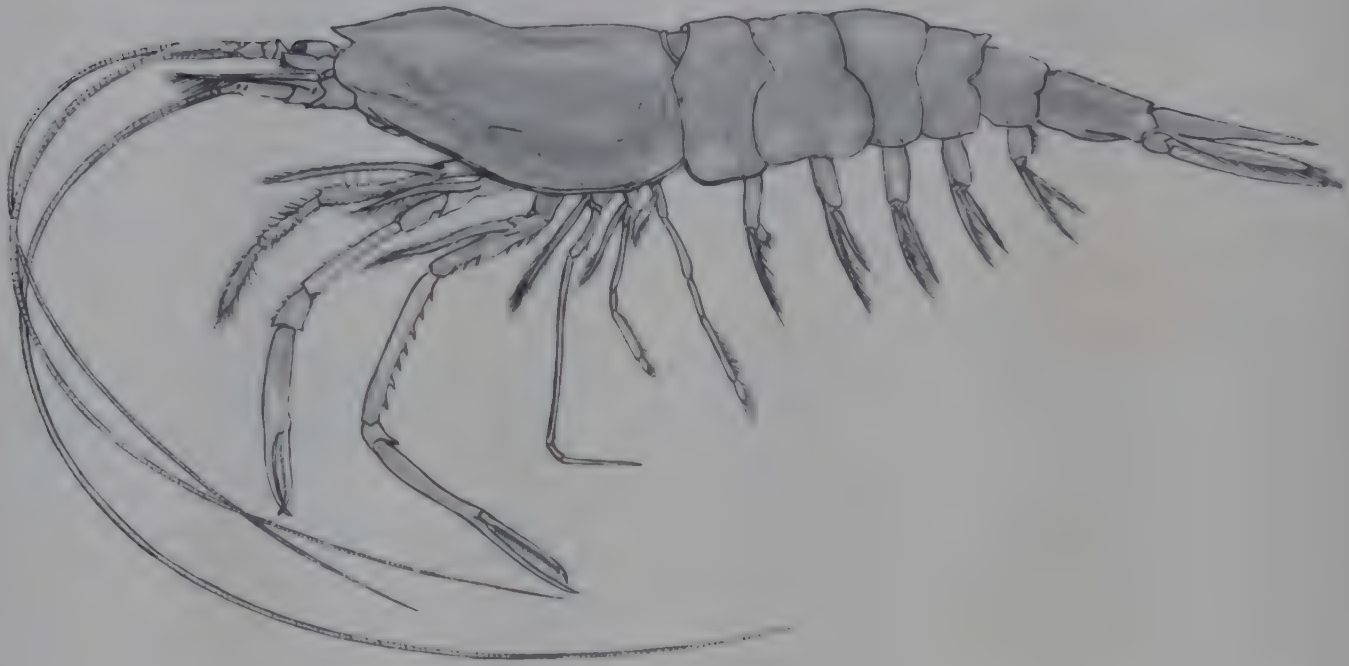
Species of this genus are moderate to large shrimps. The approximately eight known species all appear to inhabit the mesopelagic zone. Relatively little is known of their biology.

One species occurs in British Columbia waters.

GROOVED-BACK SHRIMP

Parapasiphae sulcatifrons Smith, 1884





Description Body moderately deep, somewhat compressed. Shell thin, surface smooth. Rostrum as extension of frontal margin, short, about 0.1 carapace length, slightly ascending, tip acute. Carapace: dorsal carina extending almost to posterior margin, arched in gastric region, and anterior fourth to third with pronounced median sulcus; pronounced lateral carina from near base of antenna across branchial region, curving up to posterior lateral margin, a short oblique branch to ventral margin adjacent to base of pereiopod I; also a short oblique carina from orbit to hepatic region; suborbital angle slightly rounded. Eye small, cornea and stalk depressed slightly, lightly pigmented, tubercle as extension of inner ridge. Antennule: peduncle long, third segment longer than second; stylocerite moderately long, knifelike; inner flagellum about as long as carapace, very slender, outer shorter. Antenna: scale shorter than telson, outer margin slightly convex, spine exceeding lamella; basicerite, upper lateral lobe, lower strong spine; peduncle long; flagellum shorter than body. Third maxilliped: long, moderately stout, setiferous; exopod; epipod. Pereiopods: all with exopods, from II latter decreasing in length posteriorly; I longer than third maxilliped, stout; propodus, outer surface slightly concave; dactylus and fixed finger slender, scissorlike, both inner margins finely toothed, about 0.72 proximal propodus length; II longer than I, stout; basis, 3 or 4 spines; ischium, 0-2 spines; merus, 5-7 spines; propodus constricted at distal end of palm, outer surface convex; dactylus and fixed finger slender, scissorlike, both inner margins finely toothed, not longer than palm; III shorter than II, very slender; ischium, 0 or 1 spine; dactylus spiniform, length relative to propodus unavailable; IV about half length of III; stouter; propodus flattened, many closely spaced spinules on flexor margin; dactylus flattened, long spinules on flexor margin and rounded tip, about 0.3 propodus length; V longer than IV, as slender; propodus, on flexor margin group of long setae; dactylus flattened, long setae on flexor margin and rounded tip, about 0.32 propodus length. Abdomen: ventral margins of pleura of first and second somites straight or slightly concave; transverse suture on dorsal surface of second somite; fourth with median dorsal carina extended as posterior spine; fifth with slight median dorsal sulcus, and ventral margin of pleuron truncated; sixth with curved lateral sulcus; telson longer than sixth, with median dorsal sulcus, tapering sharply to rounded tip armed with 6-9 spines; outer uropod longer than inner, both exceeding telson.

Color Generally scarlet, with carapace and chelae brighter than rest; eye light amber to bronze; antennae salmon-orange and other appendages like body (69).

Distinctions Distinguished by laterally compressed body; carapace with median dorsal sulcus; rostrum arising from dorsal frontal margin; and anterolateral margin without spines.

Maximum lengths Males: carapace 22.8 mm, total about 70 m; females: carapace 23.9 mm, total 83 mm (243).

Range Northeastern Pacific Ocean to Queen Charlotte Sound (61); North Atlantic Ocean, Greenland to Gulf of Guinea (1); and Indian Ocean; 501-5490 m.

First taken in British Columbia waters by *G. B. Reed* June 15, 1964, 56 km S by W of Cape St. James (51°26′N, 131°09′W), in a midwater trawl, 640-730 m below the surface (61).

Biology and economics The grooved-back shrimp occurs in the mesopelagic zone off Oregon (205). In the Sargasso Sea (69), most adults inhabit a zone 1464-1647 m below the surface, but juveniles are closer to the surface. Females, 22-26 mm carapace length, are ovigerous, and *P. sulcatifrons* is one of the few bathypelagic shrimps that has stomach occasionally everted when reaching the surface (69). Ovigerous females from the east coast of the United States were reported to have no more than 25 eggs each, and that egg dimensions were 4 × 5 mm (243). Characters of larval stages have been summarized (287).

Family OPLOPHORIDAE Dana, 1852

Rostrum variable in shape. First two pairs of pereiopods chelate, shorter than last three pairs. Last three pairs of pereiopods not abnormally long. Exopods present on all maxillipeds and pereiopods. Epipods on all maxillipeds and on the first to third or fourth pereiopods. Mandible with palp of three segments, molar and incisor processes indistinctly separated.

Seven genera are now recognized in the family. Four, *Acanthephyra, Notostomus, Systellaspis,* and *Hymenodora,* are represented off the British Columbia coast. All oplophorid species described in this Bulletin have a pelagic life in the open ocean. Many are colored more or less uniformly crimson to scarlet, and are members of what has been termed a red prawn-dark fish community (196), occurring below 500 m. Several oplophorids, not yet recorded from local waters, are known to be luminescent; these appear to have both dermal photophores and organs that produce cloudlike luminous secretions (69). Species in the family with a known larval development have five or more zoeal stages (200).

Key to genera of Family OPLOPHORIDAE

1 All, or last 5 abdominal somites dorsally carinate along dorsal midline 2

Sixth abdominal somite never dorsally carinate 3

2 No straight carina extending entire length of lateral surface of carapace; posterior margin of hepatic sulcus not delimited by oblique carina; all but first abdominal somite dorsally carinate .... *Acanthephyra* (p. 60)

One or more lateral carinae on lateral surface of carapace; posterior margin of hepatic sulcus delimited by oblique carina; all abdominal somites dorsally carinate .... *Notostomus* (p. 62)

3 Eyes small and poorly pigmented; all abdominal somites lack dorsal median carinae and posterior spines .... *Hymenodora* (p. 68)

Eyes large and well pigmented; third abdominal somite with median dorsal carina and posterior spine; fourth and fifth somites with or without median posterior spines .... *Systellaspis* (p. 65)

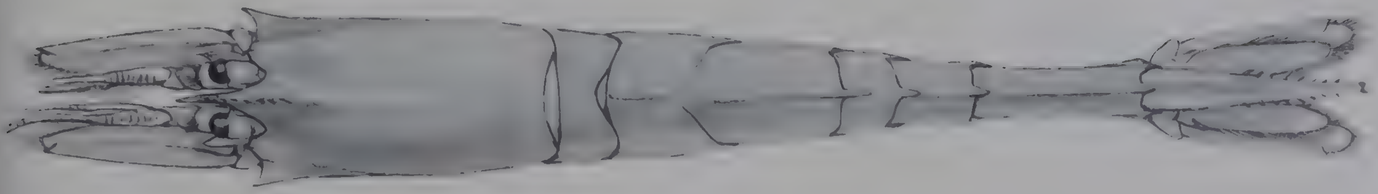
Genus *Acanthephyra* Milne-Edwards, 1881

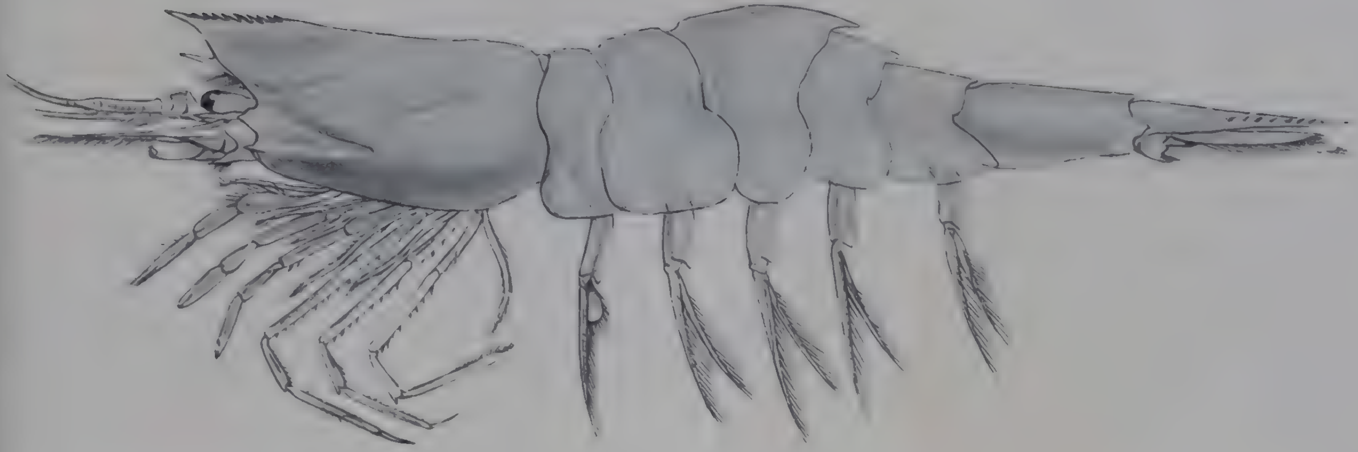
Rostrum variable in shape, with dorsal spines, with or without ventral spines. Carapace without straight carina along lateral surface from orbit to posterior margin, and without oblique carina delimiting hind margin of hepatic sulcus. Dorsal carinae on at least fourth to sixth abdominal somites. Telson truncate distally. Eyes variable in size, but well pigmented. Incisor process of mandible toothed for entire length. Eggs carried by females small and numerous.

Among 27 known species in the genus (96) are some of the most abundant and best studied oplophorid shrimps, *A. purpurea* and two or three other closely related species (69, 151, 237). The remainder, including the single species recorded from the British Columbia coast, *A. curtirostris*, appear to be uncommon or rare, and little is known of the vertical distribution and biology.

PEAKED SHRIMP

Acanthephyra curtirostris Wood-Mason, 1891





Description Body moderately deep, somewhat compressed. Shell thin but firm, surface smooth. Rostrum short to moderately long, 0.4–0.6 carapace length, as thin, triangular, obliquely ascending frontal peak, $\frac{6-9}{1-2}$, ventral normally 1, tip acute. Carapace spines and carinae: suborbital weak, slightly rounded; antennal moderate; branchiostegal strong, with flared supporting carina extending to lower hepatic region; oblique sulcus from antennal region to point above end of carina from branchiostegal spine; oblique sulcus from orbital region extending toward middorsal line; sinuous branchial carina extending from hepatic region toward posterior margin of carapace; dorsal median carina extending from rostrum along anterior two-thirds of carapace. Eye small, cornea developed, tubercle on inner surface of stalk. Antennule: peduncle short, third segment shorter than second, basal with setose distal marginal ridge; stylocerite short, tip acute; outer flagellum with thick setiferous base, total lengths of flagella unavailable. Antenna: scale shorter than telson, narrow, spine exceeding lamella; basicerite, upper lateral lobe, lower strong spine; peduncle short; length of flagellum unavailable. Third maxilliped: moderately long, moderately stout, setiferous; distal segment with longitudinal ridge; exopod short; epipod. Pereiopods: all with exopods of similar size; I–III, epipods with podobranchs; IV with reduced epipod, no podobranch; I shorter than third maxilliped, a little stouter; chelate; II longer than I, as stout; merus, 1 or 2 spines; chelate; III longer than II, more slender; ischium, 4 or 5 spines; merus, 9 or 10 and 10 or 11 spines; carpus, 8 spinules; propodus, about 45 spinules scattered over surface; dactylus about 0.33 propodus length, tip acute; IV shorter than III, similarly slender; ischium, 4–6 spines; merus, 7–9 and 8–10 spines; carpus, 1–3 spines; propodus, about 30 spinules; dactylus slender, about 0.33 propodus length, tip acute; V slightly shorter than IV, as slender; ischium, 1 spine; merus, 5 or 6 and 6 or 7 spines; propodus, on distal half of flexor margin, transverse rows of spinules form brush; dactylus short, blunt, setose.

Abdomen: pleura of first and second somites with ventral margins straight or slightly concave; second to sixth somites each with median dorsal carina, each carina, except on second, extended as strong posterior spine, that of third strongest; sixth slender, compressed, shorter than telson, posteroventral angle obtuse; telson moderately wide, tapering abruptly to truncate tip, armed distally with 4 spines, sulcate proximally, with 8–12 pairs dorsolateral spines; outer uropod longer than inner, and as long as or shorter than telson.

Color In life crimson (69).

Distinctions Separated from other oplophorid pelagic shrimps, known to occur in British Columbia waters, by markedly compressed body, especially abdomen; rostrum as triangular frontal peak, armed with 6–9 dorsal spines, and normally 1 strong ventral spine; dorsal median carinae on second to sixth abdominal somites, produced on all except second as strong posterior spines.

Maximum lengths Males: carapace 16.3 mm, total about 69 mm; females: carapace 19.4 mm, total 79 mm.

Range Pacific Ocean, Vancouver Island to Panama and Peru, and Japan, Philippines, Hawaii; Indian Ocean, east coast of Africa; Atlantic Ocean, Caribbean region, west coast of Africa, and Madeira; 200–2000 m (273, 90, 1).

Collected first in Canadian waters by *G. B. Reed,* W by SW of Cape Scott, Vancouver Island (50°56.4′N, 130°12.2′W), maximum depth 2178 m, Sept. 11, 1964 (61).

Biology and economics This species is relatively rare off the British Columbia coast, as well as off Oregon (205), and in the Atlantic Ocean off the African coast (1). In the tropical eastern Atlantic Ocean, *A. curtirostris* has a bathypelagic distribution, occurs most abundantly at 1000–1250 m, and apparently does not undergo any pronounced diel migration (96).

Genus *Notostomus* A. Milne-Edwards, 1881

Rostrum elongate with dorsal and ventral spines. Lateral surface with more than one straight carina from orbit to posterior margin of carapace, and with oblique carina delimiting posterior margin of hepatic sulcus. Abdominal somites dorsally carinate. Distal end of telson truncate. Eyes well pigmented. Incisor process of mandible toothed for only half length of cutting edge. Eggs small.

There are about 10 known species in the genus. According to published records (179, 69), species of *Notostomus* appear to be more limited in distribution than is general among oplophorids. Very little is known of the vertical distribution and biology.

One species, *N. japonicus,* is known from the west coast of Canada. Carinae on the lateral surface of the carapace are known by special terms (Fig. 12).

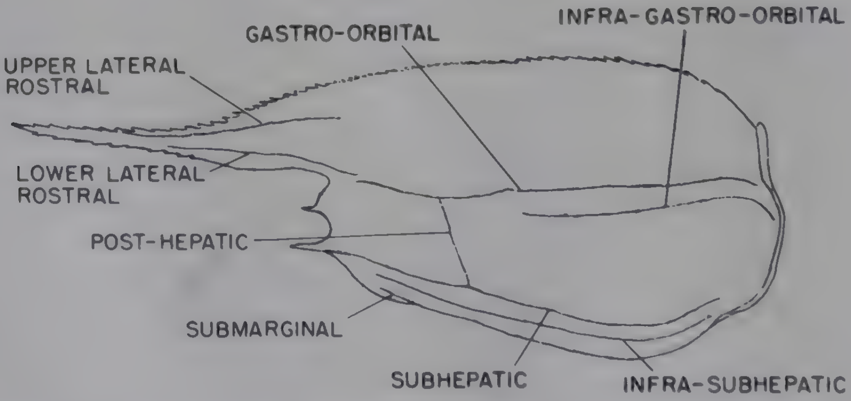
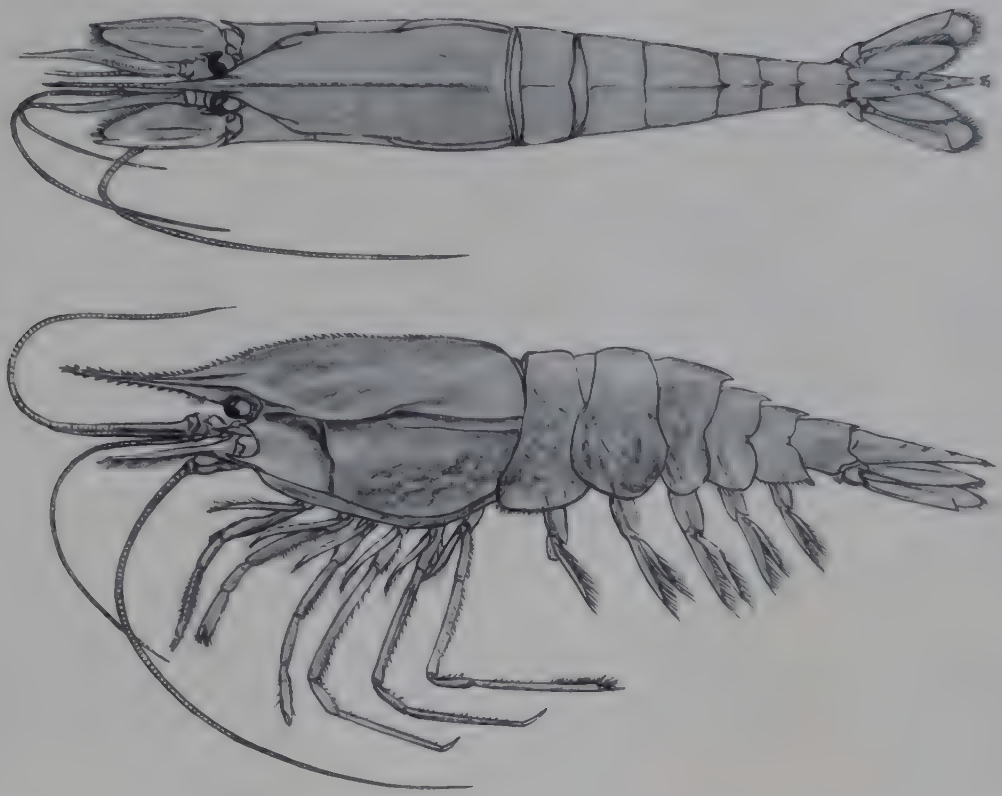


FIG. 12. Hypothetical carapace of *Notostomus,* showing carinae (after Stevens and Chace, 1965).

SPINY RIDGE SHRIMP

Notostomus japonicus Bate, 1888



Description Body stout, somewhat compressed; carapace deep, dorsal margin distinctly arched above eye in large specimens, less so in juveniles. Shell thin, surface rugose on posterior part of carapace and on pleura. Rostrum moderately long, 0.7–1.5 carapace length, with upper and lower lateral carinae, ascending, $\frac{55-83}{10\ 18}$, including 35–50 dorsal spines, smaller than those on rostrum, on prominent carina extending almost to posterior margin, tip acute. Carapace spines and carinae (Fig. 12): suborbital acute to rounded; antennal moderate; branchiostegal extends beyond basicerite: gastro-orbital extends from below lower lateral rostral to near posterior margin; subhepatic extends from branchiostegal spine to lower posterior branchial region; 2 carinae described above joined by short oblique posthepatic; submarginal forms most of lower margin of carapace in lateral view; infra-gastro-orbital extends about two-thirds distance between posterior margin and posthepatic carina; short oblique carina extends from gastro-orbital at point anterior to end of infra-gastro-orbital; depressed hepatic to antennal region. Eye small, cornea well developed, small tubercle on inner surface of stalk. Antennule: peduncle short, third segment subequal to second, basal with bladelike outer distal spine; stylocerite short, tip acute; lengths of flagella unavailable, outer thick at base. Antenna: scale as long as telson, spine exceeds lamella; basicerite with upper lateral lobe and lower strong spine; antenna length unavailable. Third maxilliped: moderately long, stout, proximal segment appears twisted due to longitudinal sulci, with distal spine, penultimate and distal segments triangular, latter with line of 10–19 spines, and with trowellike tip; exopod; epipod with podobranch. Pereiopods: all with exopods of similar size; I–III, epipods with podobranchs; IV, stubby epipod, without podobranch; I shorter than third maxilliped; moderately stout; ischium and merus flattened; when chela flexed, 2 long spines of dactylus fit over spiny extension of fixed finger, latter with serrated margin; II longer than I, more slender; ischium and merus flattened, latter with 2 or 3 spines; chela as in I; III longer than II, ischium sulcate, 8–14 spines; merus, line of 16–25 spaced spines, and shorter more distal line of 5–17 spines, lines separated by sulcus; carpus, 5–8 spines; propodus, about 30 scattered spinules; dactylus slender, about 0.22 propodus length; IV as long as III, more slender; ischium with pronounced sulcus, 10–17 spines; merus, line of 16–24 spaced spines, another of 12–19 unevenly spaced, separated by sulcus; carpus, 3–7 spines; propodus, about 30 scattered spinules; dactylus as in III; V slightly longer than IV, as slender; ischium sulcate, 12–16 spines; merus, line of about 18 spaced spines, another of 12–18 unevenly spaced, separated by sulcus; carpus, 4 or 5 spines; propodus, 10–12 scattered spinules on proximal two-thirds, rest with line of 5, closely spaced setae; dactylus very short, bladelike, tapering to curved acute tip, minute spines on flexor margin, hooked basal spine. Abdomen: each somite with median dorsal carina, those of third to sixth produced posteriorly as long acute spines; pleura of first to fifth with marginal carinae, on second, faint; fourth, widely recessed articular knob, fifth as on fourth, posterolateral spine weak; sixth, posteroventral angle obtuse; telson moderately wide, tapering to blunt tip with 5 distal spines, dorsal sulcus, 3 or 4 pairs dorsolateral spines; outer uropod longer than inner, former reaches tip of telson.

Color Crimson overall, except carinae on carapace, and on lower abdominal pleura, which are conspicuously darker (Plate 4B).

Distinctions Known by deep carapace, with 3 prominent lateral carinae; many (55–83) dorsal spines, continuous from rostral tip to near posterior margin of carapace; presence of dorsal median carinae on first to sixth abdominal somites, those on third to sixth produced as long acute spines.

Maximum lengths Males: carapace 42.0 mm, total about 151 mm; females: carapace 44.2 mm, total about 153 mm.

Range North Pacific Ocean; Alaska to Oregon (273); off Honshu Island, Japan (26); 200–1000 m below the surface (205).

The first known capture of *N. japonicus* off the Pacific coast of Canada was by the *Brown Bear*, at 49°50′N, 133°20′W, at 400 m below the surface, Sept. 24, 1958 (251).

Biology and economics Little is known of the biology. Males apparently approach sexual maturity at carapace lengths above 30 mm (251); only 1 ovigerous female, carapace length 37.0 mm, is known (273). An unidentified branchial isopod infests this shrimp (251). Daytime trawling May 31, 1972, with a large Engel midwater trawl off Cape Flattery, at 500 m and more below the surface, in maximum depths 1830–2560 m, yielded fewer *N. japonicus* than *Sergestes similis* but almost as many as specimens of *Hymenodora frontalis* or *Bentheogennema borealis.* Of 48 specimens (20 ♀, 28 ♀) sexed and measured, 21 (9 ♀, 12 ♀) had carapace lengths 30.0–44.2 mm. In a sample of 32 specimens collected earlier at 225 and 400 m by an Isaacs-Kidd midwater trawl (251), only 2 males measured more than 30.0 mm carapace length. The higher proportion of large individuals caught by the Engel trawl may have been due to the greater trawling depth, or that large shrimps were less successful at evading this trawl. About half the specimens taken off Cape Flattery were kept alive aboard *G. B. Reed* in plastic pails in a household refrigerator (5°C) for 2 days, and for 2 wk longer at the Pacific Biological Station, until a malfunction in the seawater system killed them. While alive, the shrimps swam with carapace down in an almost vertical posture.

Genus *Systellaspis* Bate, 1888

Rostrum well developed. Carapace without horizontal carina, or oblique carina delimiting the posterior margin of the hepatic sulcus. Sixth abdominal somite not dorsally carinate. Telson not truncate at tip, but ending in a sharply pointed distal element, laterally armed with spines. Eyes well pigmented, normally moderate to large. Eggs large.

The genus has five known species (273). Other than *Systellaspis debilis,* (A. Milne-Edwards), these species appear to be uncommon or rare.

Two species, *S. braueri* and *S. cristata,* have been captured off the British Columbia coast. The spinose telson of these shrimps has suggested the name "spinytail."

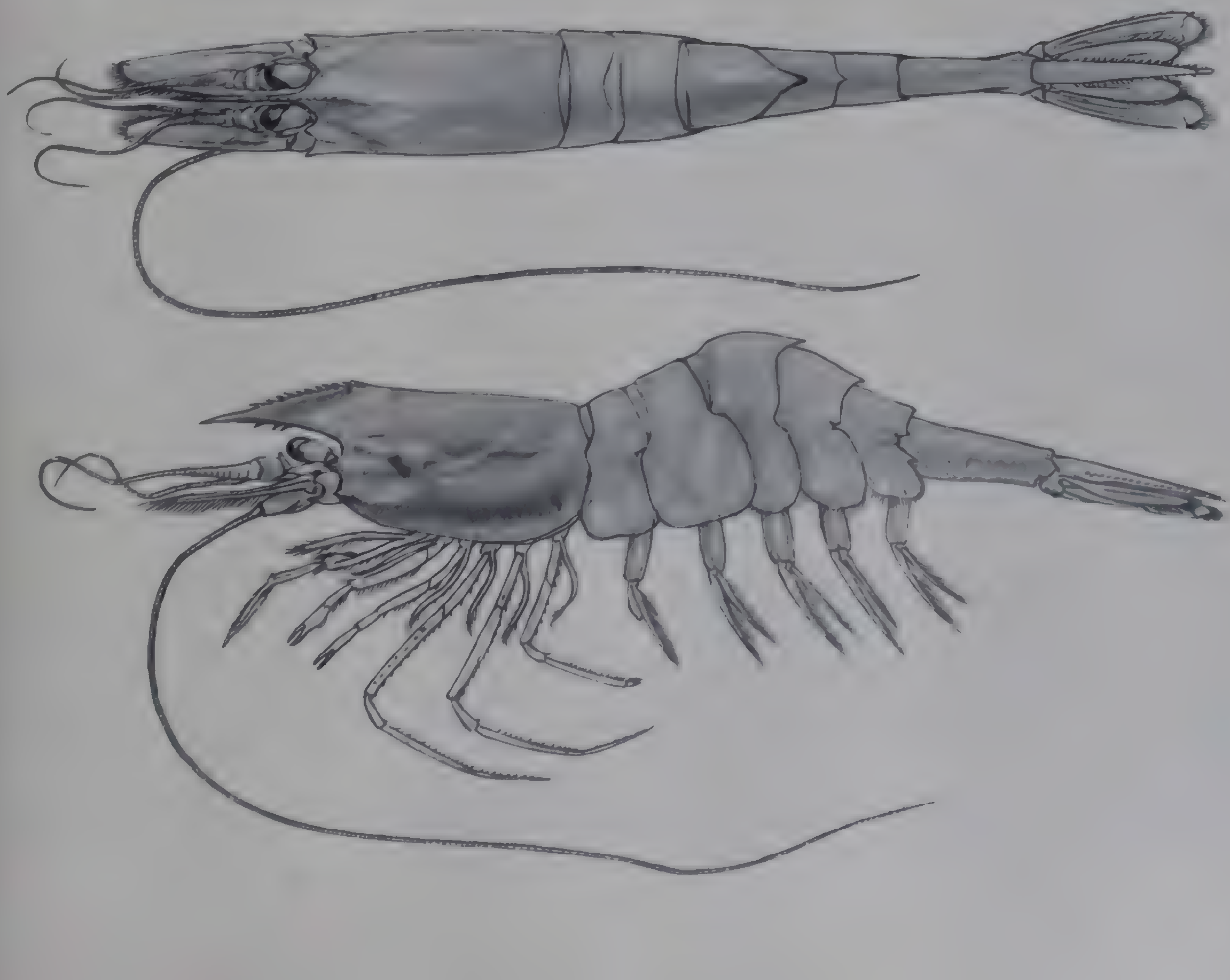
Key to species of genus *Systellaspis*

1 Rostrum triangular, normally half or less carapace length; dorsal posterior margin of fifth somite without median spine .... Quayle's spinytail, *S. braueri* (p. 65)

Rostrum slender, more than half as long as carapace; dorsal posterior margin of fifth somite with median spine .... Krygier's spinytail, *S. cristata* (p. 67)

QUAYLE'S SPINYTAIL

Systellaspis braueri (Balss, 1914)



Description Body moderately stout, somewhat compressed. Shell thin, surface smooth. Rostrum short, about 0.5 carapace length, triangular, descending, $\frac{11\text{-}12}{1\text{-}4}$, anterior third devoid of spines. Carapace spines and carinae; antennal moderate; branchiostegal moderate, with supporting carina; curved carina extends from orbit to hepatic region; posterior to this, oblique branchial carina extending upward into posterior fourth of carapace, with a short branch into cardiac region; sulcus below branchial carina; depressed area dorsal to branchiostegal spine. Eye small, cornea partly developed. Antennule: peduncle short, third segment shorter than second, ridged transverse margin on basal segment; stylocerite short, with outer lateral carina; both flagella about equal and overreach antennal scale by more than half their lengths, proximal part of outer thickened. Antenna: scale shorter than telson, spine barely exceeds lamella, outer margin slightly convex; basicerite, upper lateral lobe, lower strong spine; peduncle short, stout; total length of flagellum unavailable. Third maxilliped: moderately long, slender, setiferous; proximal and distal segments slightly twisted; exopod; epipod with podobranch. Pereiopods: all with exopods similar in size; I–III, epipods with podobranchs; IV, epipod without podobranch; I shorter than third maxilliped, slightly stouter; chelate; II about as long as I, more slender, especially chela; ischium, 1 spine; merus, 1 spine; chelate; III longer than II, about as slender; ischium, 3–5 spines; merus, 10–12 spines, 1 row; carpus, 0 or 1 spine; propodus tapering; 12–18 spinules; 1 or 2 rows; dactylus slender, about 0.8 propodus length, 8–10 spinules, tip acute; IV shorter than III, as slender; ischium, 4–7 and 2 spines; merus, 9–13 spines, 1 uneven row; carpus, 0 or 1 spine propodus, tapering, 14–16 spinules, 1 or 2 rows, others scattered; dactylus slender, about 0.7 propodus length, 8–10 spinules, tip acute; V shorter than IV, as slender; ischium, 3 or 4 spines; merus, 4 or 5 spines; carpus, 0 or 1 spine; propodus, distal three-fourths flexor margin with transverse rows of spinules forming brush, long distal setae; dactylus very short, rounded tip, long curved distal setae. Abdomen: anterior lateral margin of first pleuron with slight lobe; ventral margins of first and second pleura straight or slightly concave; third somite with weak dorsal median carina, produced prosteriorly as strong spine; fourth with or without median dorsal carina, but with moderate posterior spine; weak spine on fifth above articular knob, and moderate decurved spine below knob; sixth slender, shorter than telson, posteroventral angle extended laterally, appearing flared in dorsal view; telson narrow, tapering to sharp, spinose distal element, 20–30 lateral spines in 1 or 2 rows on each side; outer uropod longer than inner, not reaching tip of telson.

Remarks As first collection of species was made in the course of a faunistic survey conducted by D. B. Quayle, it is appropriate the common name should be Quayle's spinytail.

Color Not available, but *S. braueri* was included in a list of deep mesopelagic shrimps with a more or less uniform pigmentation, varying from deep red to brown-red (95).

Distinctions This species is distinguished from other oplophorid shrimps, including *S. cristata,* by its short, triangular rostrum, with distal third free of spines (B.C. specimens); a weak spine above the articular knob on the posterolateral margin of the fifth abdominal pleuron, and a moderate decurved spine below the knob.

Maximum lengths Males: carapace 27.1 mm, total 110 mm; females: carapace 35.6 mm, total 138 mm.

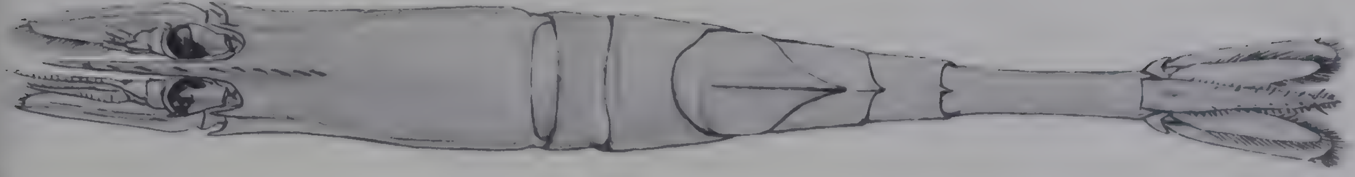
Range Northeastern Pacific, Vancouver Island to Los Angeles (69, 205, 61); Atlantic Ocean, Newfoundland to Bermuda (69, 237), Ireland to Gulf of Guinea, Indian Ocean (237); within 200 m of the surface to 4000 m (237).

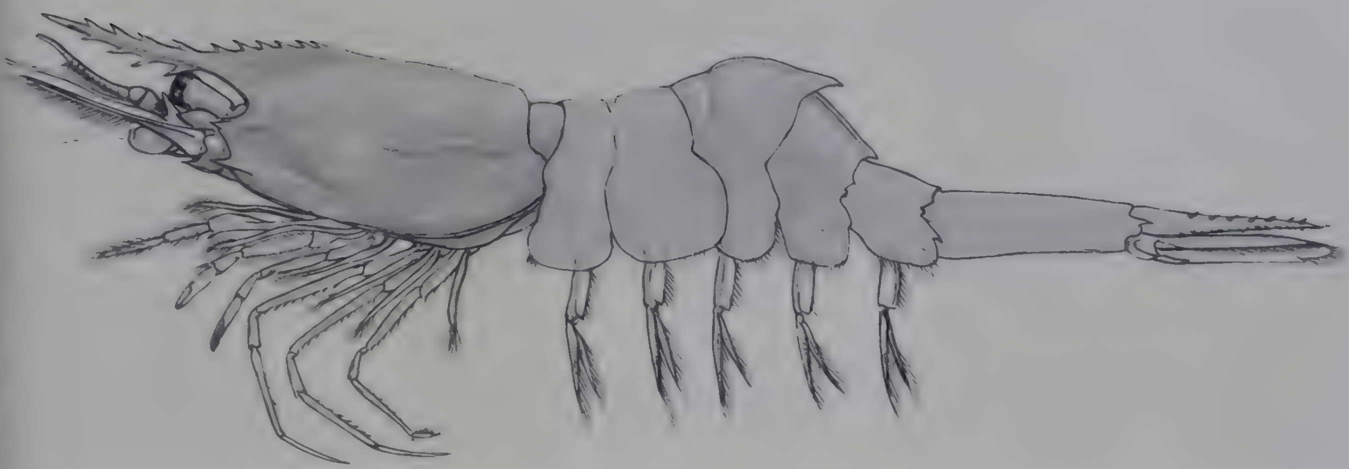
The first known capture of the species off the British Columbia coast was by *G. B. Reed* off Estevan Point (49°19.0′N, 127°26.6′W), at maximum depth of 1460 m, Sept. 9, 1964 (61).

Biology and ecomomics Nothing appears to be known of the biology of this relatively rare shrimp.

KRYGIER'S SPINYTAIL

Systellaspis cristata (Faxon, 1893)





Description Body moderately stout, somewhat compressed. Shell thin, surface finely pitted. Rostrum moderately long, 0.7–0.9 carapace length, with prominent lateral carina extending from orbit, ascending, $\frac{10\text{-}14}{4\ 8}$, tip acute. Carapace spines and carinae (as in Fig. 12): suborbital weak; antennal moderate; branchiostegal strong, with supporting carina: gastro-orbital extends from orbit (or below antennal spine) to posterior margin, interrupted by thickening of shell in hepatic region; submarginal extends from below carina of branchiostegal spine to posterior margin of carapace, widening in branchial region. Eye moderate, cornea well developed, lobular process on inner surface of stalk. Antennule: peduncle short, third segment with dorsal distal spine and shorter than second, basal with hoodlike anterior margin and prominent lateral spine, lengths of flagella unavailable. Antenna: scale slightly longer than telson, narrow, spine exceeds lamella; basicerite with upper lateral lobe and lower strong spine; peduncle short; length of flagellum unavailable. Third maxilliped: moderately long, slender except distal end of proximal segment, latter with spine; exopod; epipod with podobranch. Pereiopods: all with exopods of similar size; I–III, epipods with podobranchs; IV, short epipod, without podobranch: I shorter than third maxilliped, moderately stout, chelate; II slightly longer than I, slender; merus, 1 spine; chelate; III longer than II, slender; ischium, 5 spines, about 20 spinules; merus, 13, 7 or 8 spines, 2 rows; propodus, 6–8 spinules, dactylus slender, about 0.8 propodus length, about 8 minute spines, tip acute; IV shorter than III, slender; ischium, 5 spines, 24 spinules; merus, 13, 8 spines, 2 rows; propodus, 8–10 small spines; dactylus slender, about 0.8 propodus length, about 10 minute spines, tip acute; V shorter than IV, slender; ischium, 4 spines; merus, 5, 6–8 spines, 2 rows; carpus, 1 spine; propodus, numerous spinules in obliquely transverse rows, thicker on distal third forming brush; dactylus paddlelike, about 0.2 propodus length, long spinules on flexor margin and rounded tip. Abdomen: pleuron of first somite with lobe on anterior lateral margin; third somite with dorsal median carina, extending from anterior transverse sulcus to sharp posterior spine; fourth with dorsal carina along entire somite, and produced as moderate posterior spine; fourth and fifth each with lateral carina, along entire length of somite; posterolateral margin of fourth with spine above articular knob, and slight lobe below; fifth with moderate median posterior spine, and posterolateral margin with weak spine above articular knob, and strong decurved spine below; sixth slender, about 2.5 length of fifth, weak posteroventral spine, slightly flared; telson narrow, tapering to sharp distal element beyond 2 strong lateral spines, on proximal element 7–9 pairs dorsolateral spines, and 18–21 pairs lateral spines; inner uropod shorter, outer uropod with movable distal spine on outer margin, not reaching tip of telson.

Remarks *S. cristata* was given the common name after E. E. Krygier, Oregon State University carcinologist, who brought the true identity of the species to the present author's attention, and provided information on its morphology. Counts of rostral spines, from specimens caught in the eastern Atlantic Ocean (1) are included above.

Color More or less uniform crimson color; lighter on rostrum, eyestalk, antennular peduncle and flagella, scale, basicerite, and peduncle of antenna (Plate 1E).

Distinctions *S. cristata* is separated from other oplophorid shrimps, including *S. braueri,* by moderately long, spikelike rostrum, armed on distal half dorsally and ventrally with 10–14 and 4–8 spines, respectively; a weak spine above articular knob on posterolateral margin of fourth abdominal pleuron, and slight lobe below; weak spine above articular knob on posterolateral margin of fifth pleuron, and strong decurved spine below.

Maximum lengths Males: carapace 17.3 mm, total about 81 mm; females: carapace 36.0 mm (1), total about 169 mm.

Range Northeast Pacific Ocean; Vancouver Island to Gulf of Panama (87, 273); Atlantic Ocean (90), Bay of Biscay (91) to Angola (80); Indian Ocean (179); 600–2500 m (80).

First captured in Canadian waters by *G. B. Reed,* 108 km W by SW of Cape Scott (50°56.4′N, 103°12.2′W), maximum depth 2178 m, Sept. 11, 1964; and recorded as *Acanthephyra quadrispinosa* (61).

Biology and economics Only 2 specimens have been taken off the British Columbia coast, and the species is relatively uncommon elsewhere (95). Two females, 16.3 and 19.0 mm carapace length, caught off the northwest coast of Africa, were ovigerous (95), another ovigerous female, 36 mm carapace length, occurred off Gibraltar (1). The last mentioned female carried large reddish-orange eggs, 3.5 × 2.5 mm (1).

Genus *Hymenodora* G. O. Sars, 1877

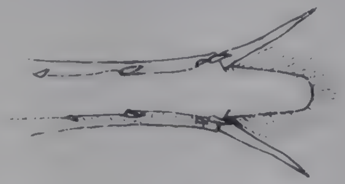
Shell thin or membranous. Rostrum relatively short with dorsal spines. Abdominal somites without dorsal median carinae and posterior spines. Telson truncate distally, or ending in an elongate, rounded distal element, laterally armed with spines. Entire cutting edge of mandible toothed. Endopod of first maxilliped composed of only two segments. Eyes small, lightly pigmented.

Members of the genus are small to medium shrimps. Four species are known. Two, *H. frontalis* and *H. glacialis,* have been recorded from the Pacific coast of Canada; the other two, *H. gracilis* Smith, 1886, and *H. acanthitelsonis* Wasmer, 1972, off Oregon. As there is some possibility that the two latter species will be found in Canadian waters eventually, they are included in the key, originally constructed by Wasmer (273). All species are fragile, particularly *H. glacialis* and *H. gracilis,* and almost without exception, specimens are damaged during capture and occasionally to such an extent that identifications are difficult.

The two local species have been given the common name, "ambereye," calling to attention the lightly pigmented cornea of the eye.

Key to species of genus *Hymenodora*

1 Telson truncate distally 2

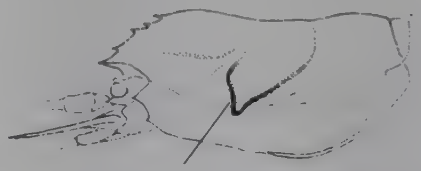


Telson terminates in an elongate, rounded distal element laterally armed with spines .... [*H. acanthitelsonis,* Wasmer, 1972]

2 Rostrum short, reaching little beyond cornea of eye 3

Rostrum longer, reaching to or beyond distal end of antennular peduncle .... Pacific ambereye, *H. frontalis* (p. 70)

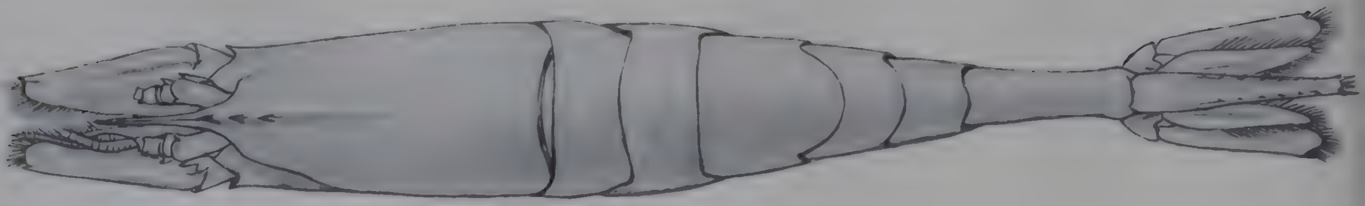
3 Podobranch present on epipod of second maxilliped, no crescent-shaped sulcus in hepatic region of carapace .... [*H. gracilis,* Smith, 1886]

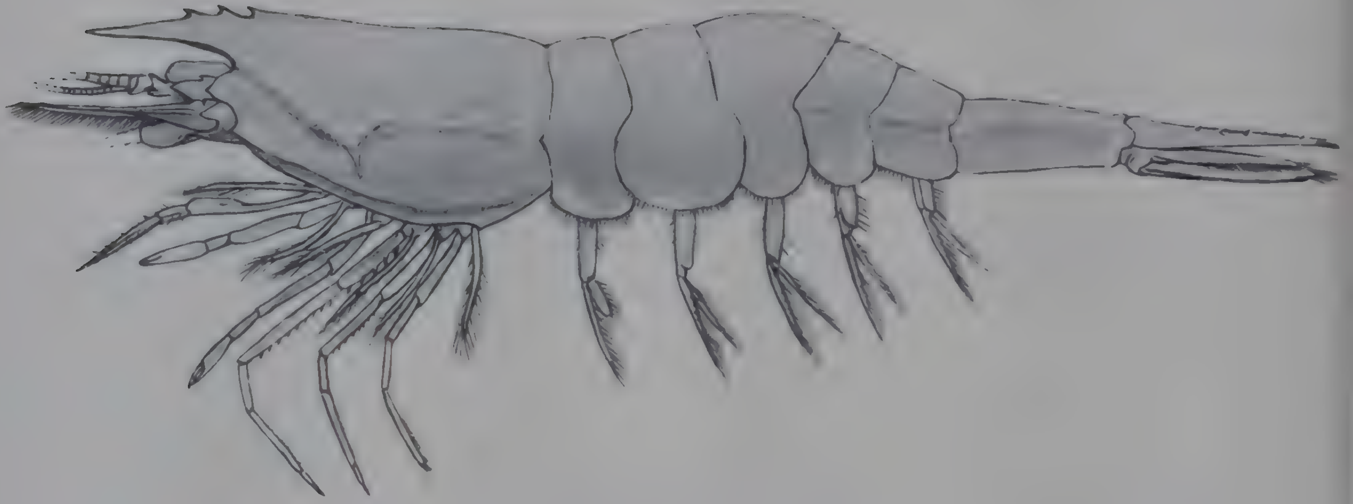


No podobranch present on second maxilliped, crescent-shaped sulcus present in hepatic region of carapace .... Northern ambereye, *H. glacialis* (p. 72)

PACIFIC AMBEREYE

Hymendora frontalis Rathbun, 1902





Description Body moderately stout, little compressed. Shell thin but not membranous, surface finely pitted. Rostrum short, 0.4–0.5 carapace length, attaining or overreaching distal segment of antennular peduncle, $\frac{3\text{-}6}{0}$, tip acute. Carapace spines and carinae: suborbital and antennal combined as large lobe; branchiostegal moderate, continues as subhepatic carina to almost posterior margin; rostral margin extending over orbit obliquely as carina to lower hepatic region, then deflected obliquely to extend toward posterior margin in line with lobe on pleuron of first abdominal somite; median dorsal carina extending from rostrum barely into the posterior half of carapace. Eye small, cornea poorly developed, amber or pale, tubercle at base of cornea on inner surface of stalk, spine on outer margin. Antennule: peduncle short, third segment subequal to second, outer distal spine on basal segment; stylocerite short, knifelike; lengths of flagella unavailable. Antenna: scale shorter than telson, moderately wide, spine exceeds lamella; basicerite, upper blunt spine, lower stronger spine; peduncle short and stout; length of flagellum unavailable. Third maxilliped: moderately long, slender, setiferous; penultimate and distal segments with lateral ridges; tip acute; long exopod, epipod with podobranch. Pereiopods: all have exopods of similar size; I–III, epipods with podobranchs; IV, stubby epipod, without podobranch; I shorter than third maxilliped, stouter; chelate; II longer than I, more slender; chelate; III longer than II, carpus and distal segments very slender; ischium, about 5 spines; merus, 9 or 10 spines; propodus, about 15 spinules, 2 or 3 rows; dactylus about 0.45 propodus length, 2 or 3 minute spines, tip acute; IV shorter than III, more slender; ischium, about 8 spines; merus, about 8 spines; propodus, about 30 spinules, 1-3 rows; dactylus about 0.45 propodus length, 5 minute spines, tip acute; V shorter than IV, as slender; propodus, about 12 rows of fine spinules on flexor margin, fine setae at distal end; dactylus very short, curved to acute tip. Abdomen: pleuron of first somite with moderate lobe on anterior margin; ventral margins of first and second somites mainly straight or slightly concave; lateral carinae on fourth and fifth somites, extending over most of their lengths, and in line with articular knobs; sixth slender, shorter than telson; telson moderately wide, tapering to rounded tip, armed with 6 distal spines, 6-9 pairs posterolateral spines, median dorsal sulcus; outer uropod, with distal movable spine on outer margin, and longer than inner uropod, both shorter than telson.

Color Orange-red over entire body; darker on carapace, third maxilliped and pereiopods; lighter on rostrum, eyestalk, antennule and antenna, first to fifth abdominal pleura, lateral surface of sixth somite, distal parts of telson and uropods, and basipodites of pleopods (Plate 5E).

Distinctions Separated from locally known oplophorids of other genera by very thin but not membranous shell; small eyes, almost colorless or amber; lack of dorsal median carina and posterior spines on all abdominal somites. Characters that set apart *H. frontalis* from *H. glacialis* and other species of the genus are its relatively long rostrum extending to or beyond end of antennular peduncle; less complex sculpturing on lateral surface of carapace.

Maximum lengths Males: carapace 14.3 mm, total about 58 mm; females: carapace 14.6 mm, total 53 mm.

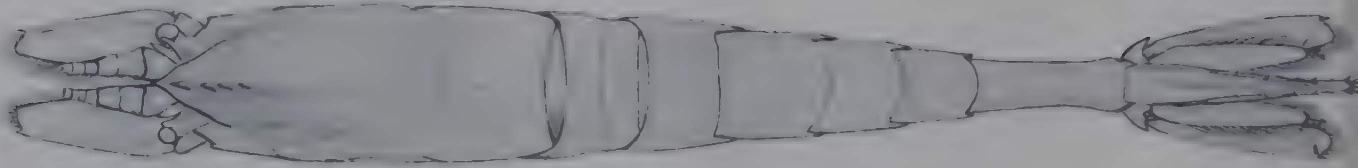
Range Pribilof Islands, Bering Sea to San Clemente Island, CA (232); Okhotsk Sea (266); within 200 m of surface to 3000 m (205).

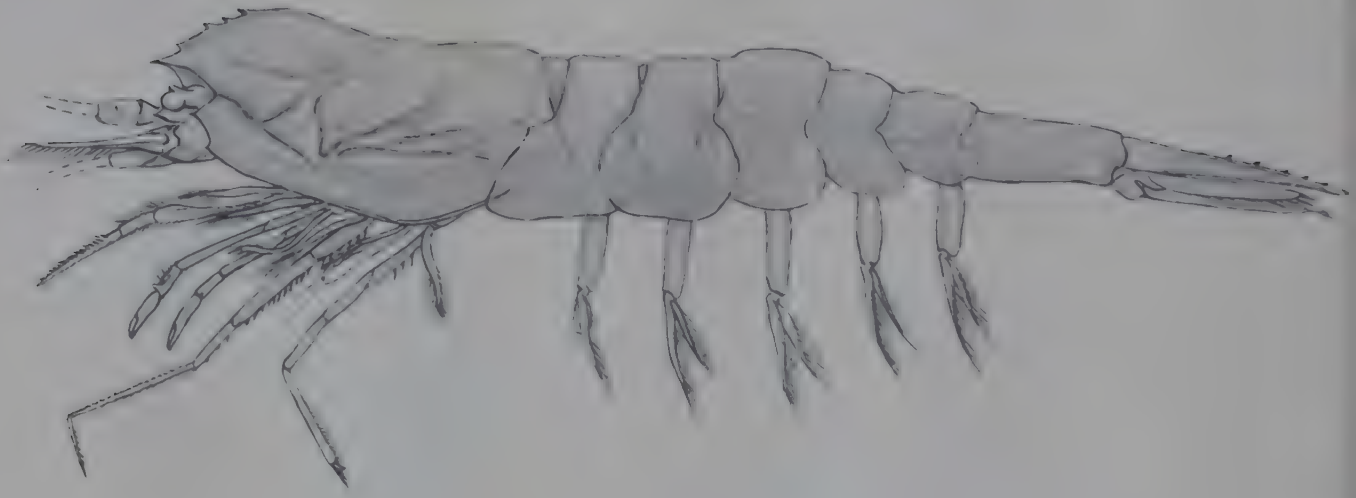
First captured in British Columbia waters by the *Albatross,* west of Moresby Island, at 2906 m, Sept. 3, 1889 (station 3342) (219).

Biology and economics *H. frontalis* is perhaps the most common oplophorid shrimp in Canadian waters. Its apparent abundance might be attributed to a poor ability to evade trawls and plankton nets. It does not migrate vertically (3).

NORTHERN AMBEREYE

Hymendora glacialis (Buchholz, 1874)





Description Body slender, somewhat compressed. Shell membranous, finely pitted over most of body surface. Rostrum generally descending from high swollen anterior part of carapace, $\frac{2-5}{0-1}$, tip acute. Carapace spines and sulci: suborbital rounded; antennal strong; branchiostegal weak; curved lateral carina in lower frontal and gastric regions; oblique sulcus extends from orbit to lower hepatic region, with branch extending toward end of carina in gastric region; adjacent to branched sulcus a crescent-shaped dorsoventral sulcus, joining oblique sulcus that extends to dorsal median line as cervical groove; main branchial sulcus extends from hepatic region toward posterior margin of carapace; above latter sulcus a deltalike complex of sulci and carinae; median dorsal carina from rostrum to cervical groove. Eye small, cornea poorly developed, amber or colorless, stalk compressed, tubercle on inner margin. Antennule: peduncle moderately long, stout, third segment subequal to second; stylocerite short; lengths of flagella unavailable. Antenna: scale shorter than telson, moderately wide, lamella exceeds spine; basicerite, upper lateral lobe covering part of outer basal part of antennal scale, lower spine strong; peduncle short; length of flagellum unavailable. Third maxilliped: moderately long, moderately stout, setiferous; exopod; epipod with podobranch. Pereiopods: all with exopods about equal in size; I–III, epipods with podobranchs; IV, stubby epipod without podobranch; I shorter than third maxilliped, as stout; carpus flattened, distal tubercle; chelate; II about as long as I, as stout; chelate; III much longer than II, tapering; ischium, 6 or 7 spines; merus, 11 or 12 spines; carpus, 3 spinules; propodus, numerous spinules over whole segment; dactylus about 0.45 propodus length, 6 minute spines, tip acute; IV, pereiopod unavailable; V shorter than III, mainly more slender; ischium, 3 spines; propodus, distal two-thirds flexor margin with transverse rows of setae forming brush, long setae on distal end; dactylus short, hook-shaped, setae on flexor margin and tip. Abdomen: anterolateral margin of pleuron of first somite projected forward, small lobe on upper part of margin, faint transverse sulcus; second pleuron with 2 oblique sulci converging above ventral margin; third with dorsoventral sulcus roughly paralleling posterolateral margin; on fourth, a lateral carina at level of articular knobs; similar carina on fifth; sixth about as long as fourth and fifth together, compressed slight oblique lateral sulcus, posteroventral angle obtuse; telson moderately wide, tapering to blunt tip, median sulcus, 5 or 6 pairs dorsolateral spines; outer uropod with movable spine at distal end of outer margin, longer than inner uropod, both shorter than telson.

Remarks Presence of a single ventral rostral spine is shown above. Spine was observed on a specimen from the Oregon State University collection (MT2177 No. 1).

Color Blood red (222).

Distinctions Distinguished from other local oplophorids (including *H. gracilis,* if encountered) by crescent-shaped dorsoventral sulcus on lateral surface of carapace; carpus of pereiopod I somewhat flattened and slightly setose, with a prominent distal tubercle.

Maximum lengths Males: carapace 16.2 mm, total about 48 mm; females: carapace 16.8 mm, total, 45 mm.

Range Not known with certainty, because of the earlier confusion with *H. gracilus.* In the North Pacific Ocean, *H. glacialis* probably occurs from the Bering Sea (219) to the Gulf of Panama (88), also in the Okhotsk Sea (266). It is known from the arctic region, and in the North Atlantic Ocean southward to 30°N (237). Taken in depths to 3900 m (237).

The first confirmed capture of the species in British Columbia waters was by *G. B. Reed* in a naturalist's dredge, west of Triangle Island (50°56.3′N, 130°12.0′W), maximum depth 2013 m, Sept. 11, 1964.

Biology and economics This species appears less common locally than *H. frontalis.* In the western Atlantic Ocean, small numbers of adult *H. glacialis* were caught in the bathypelagic zone, but young specimens occurred shallower (276). Apparently, the degenerate eye is receptive to light but is not equipped for vision (276). A reported parasite is the rhizocephalan *Trachelosaccus hymenodorae* (40).

Family CRANGONIDAE White, 1847

Rostrum if present, generally short, usually flattened and without spines; or absent. Eyes generally free. Mandible with molar process, without incisor process and palp. First pereiopod stouter than second and subchelate. Second pereiopod, if present, slender and equal, carpus unsegmented, chelate or dactylus simple. Body generally depressed.

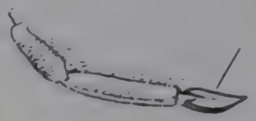
Zarenkov's (298) proposed revision of the genera *Crangon* Fabricius, 1798 and *Sclerocrangon* G. O. Sars, 1883 in the family is accepted, with the exception of his concept of establishing two subgenera in *Crangon.* Comments on the revision will be included with each appropriate generic description. On the west coast of Canada, therefore, seven genera are represented: *Crangon, Mesocrangon Metacrangon, Argis, Sclerocrangon, Rhynocrangon,* and *Paracrangon.*

Most members of the family live in the north temperate and arctic regions of both hemispheres; the others occur in the tropics, antarctic, and at great depths in all oceans (202). Species of three genera, *Mesocrangon, Paracrangon,* and *Rhynocrangon,* are restricted to the North Pacific region.

Key to genera of Family CRANGONIDAE

1 Second pereiopod absent .... *Paracrangon* (p. 75)

Second pereiopod present 2

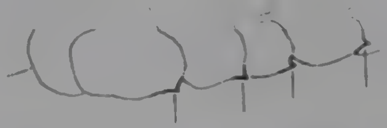


2 Dactyli of fourth and fifth pereiopods flattened; eyes partly concealed by dorsal frontal margin of carapace .... *Argis* (p. 77)

Dactyli of fourth and fifth pereiopods normal, moderately stout to slender; eyes free 3

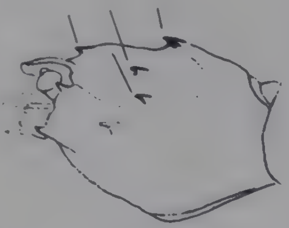
3 Shell heavily sculptured or knobby 4

Shell smooth or lightly to moderately sculptured 5



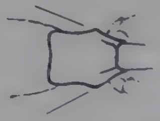
4 Three or 4 median dorsal spines on carapace; pleura of second to fifth abdominal somites with posteroventral spines .... *Sclerocrangon* (p. 90)

Two median dorsal spines on carapace; pleura of second to fifth somites without posteroventral spines .... *Rhynocrangon* (p. 92)

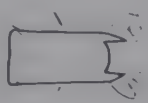


5 Two median dorsal spines on carapace; 1 or more submedian spines 6

One or 2 median dorsal spines, submedian spines absent .... *Crangon* (p. 95)



6 Moderate sculpturing on abdomen; posteroventral angle of sixth somite strongly flared .... *Metacrangon* (p. 114)



Little or no sculpturing on abdomen, posteroventral angle of sixth somite not flared .... *Mesocrangon* (p. 120)

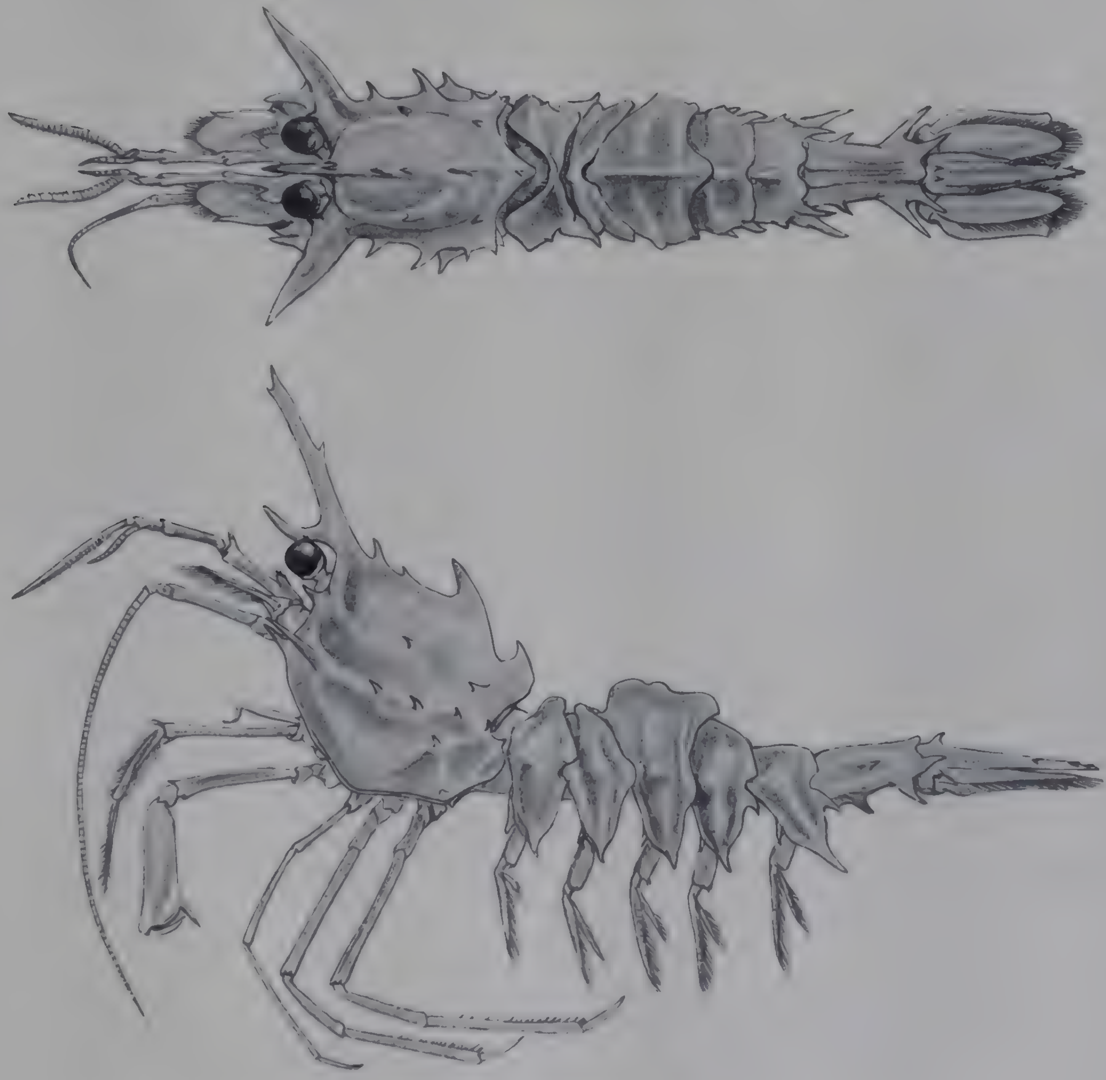
Genus *Paracrangon* Dana, 1852

Rostrum long, obliquely erect. Eyes free, tubercle absent. Lateral surface of carapace spiny, branchiostegal spine hornlike. Second pereiopod absent. Pleura of first to fifth abdominal somites with acute ventral margins. Lateral surface of sixth somite with prominent spines.

Two species are known in the genus. *A. echinata* occurs on the British Columbia coast, and *A. areolata* Faxon, 1895, lives in deep water off the west coast of Mexico.

HORNED SHRIMP

Paracrangon echinata Dana, 1852



Other common name: spike shrimp

Description *Male* Moderately stout, depressed. Shell thick, surface sculptured and spinose. Rostrum moderately long, about carapace length, obliquely erect, slender, trailing edge with 1 moderate spine near middle, leading edge with 1 moderate spine near tip and 1 long curved spine at base, tip acute. Carapace spines and carinae: 4 dorsal median spines lie on median carina, 2 anterior spines smaller; antennal strong; branchiostegal, massive, flared anterolaterally; pterygostomian very strong, reaches to or beyond basicerite of antenna, and tip in line with tip of branchiostegal; dorsolateral surface with 8 or 9 moderate, recurved spines, and carinated forming irregular, quadrangular, depressed areas, with most spines at angles; 4 or 5 spines, including branchiostegal, lie on an irregular lateral carina; posterior margin of carapace, bearing rear median spine, greatly produced into deeply concave margin of first abdominal somite; deep, wide sulcus lies from base of posterior median spine, across cardiac region, above and parallel to lateral carina, to frontal margin, between antennal and branchiostegal spines. Eye moderate, cornea well developed. Antennule: peduncle very long, second segment over twice length of third, latter with dorsal distal spine, first with dorsal distal setose tubercle; stylocerite short, tip rounded, setose; inner flagellum about half length of outer. Antenna: scale short, moderately wide, outer margin concave, lamella exceeding spine; basicerite unarmed laterally; peduncle very long; flagellum shorter than body. Third maxilliped: long, slender; distal spine on proximal segment; exopod short, with lash. Pereiopods: I about as long as third maxilliped, moderately stout, except chela; merus with distal spine; propodus moderately long, widens distally, 4.0–5.0 average width, fixed finger strong, slender; dactylus when flexed obliquely transverse; II absent on this species; III longer than I, very slender; dactylus about 0.27 propodus length, tip acute; IV longer than III, stouter; propodus, 13–15 spinules, 1 row, most on distal third; dactylus slender, about 0.38 propodus length, tip acute; V longer than IV, as stout; propodus, 18–23 spinules, 1 row, most on distal half; dactylus slender, about 0.36 propodus length, tip acute. Abdomen: first and second somites with median dorsal elevation and tubercle, respectively; third with high median carina with posterior projection; fourth and fifth each with lower, yet conspicuous carina; dorsal anterior margin of first deeply concave; dorsal posterior margins of first, second, fourth, and fifth, each widely notched; dorsolateral surfaces, including pleura, of first to fifth somites, each with 2 wide vertical sulci; pleura of first to fifth with ventral margins strongly acute and flared; strong decurved spine on each posterolateral margin, below articular knob of fourth and fifth; conspicuous articular knob on posterolateral margin of first; inside each pleuron of first to fifth somites, and originating on lateral edge of sternum, is strong spine extending beyond lower anterolateral margin; sixth with 2 median dorsal carinae, converging posteriorly, with strong spine arising from lower lateral surface, a variable midlateral spine, with very strong posteroventral and posterodorsal spines, each flared laterally, and 2 strong ventral spines; telson moderately wide, tapering to acute tip, 2 median dorsal spines located at anterior end of median sulcus, 3 pairs dorsolateral spines in distal half; inner uropod slightly longer than outer, latter with concave outer margin and blunt setose posterolateral spine or lobe, tip of telson extends beyond uropods. *Female* Rostrum shorter, 0.6–0.8 carapace length, and wider at base than on male; absent are lateral sternal spines, conspicuous inside anterolateral margins of first to fourth abdominal pleura, present on fifth; dorsolateral surface of carapace, 6–10 spines.

Remarks Deeply concave dorsal margins of first somite and notched posterior dorsal margins of second, fourth, and fifth somites facilitate movement of these somites, enabling shrimp to assume defensive cataleptic position, appearing as if telson were about to touch rostrum.

Color Background light brownish gray, generally overlaid with small brown or black spots; distinct larger spots of same hue along dorsal and ventral margins of carapace and abdomen; spots sparse on pereiopods III–V, lacking on antennule, antenna, and third maxilliped (Plate 2D).

Distinctions Distinguished from all other British Columbia shrimps by its spiny body; long, obliquely erect rostrum; long, massive branchiostegal spines (suggesting shrimp's common name); absence of pereiopod II.

Maximum lengths Males: carapace 11.2 mm, total 44 mm; females: carapace 13.9 mm, total 65 mm. Total length taken from tip of lower anterior spine of rostrum.

Range Port Etches, AK (219) to La Jolla, CA (232); Okhotsk Sea; Sea of Japan to Korea Strait; Sagami Bay (266); 7–201 m (232).

First known capture of *P. echinata* in Canadian Pacific waters was by J. Richardson near Bella Bella, at 18–54 m, in 1874 (279).

Biology and economics The horned shrimp is fairly common along the entire British Columbia coast, generally shallower than 91 m. During capture, specimens invariably are observed to be in the cataleptic position. Ovigerous females, 10.3–13.9 mm carapace length, were found in May, June, August, September, and November. Second and fifth stage larvae, identified as *P. echinata,* were described (176).

Genus *Argis* Krøyer, 1842

Two to four dorsal median spines on carapace; fourth spine, if present, most anterior in position and weak. True rostrum absent, but rostral or anterior spine adjacent to frontal margin. Eye small, with tubercle, partly concealed by hood formed by fusion of rostral, postorbital and antennal spines. Branchiostegal and ptyergostomian spines present. Mandible with molar process but no incisor process or palp. Second pereiopod slender, chelate. Fourth and fifth pereiopods stout, dactyli flattened. Distal segment of third maxilliped flattened, tip rounded.

The generic name *Argis* takes precedence over *Nectocrangon* Brandt, 1851 (131).

The dactyli of the fourth and fifth pereiopods were described as natatorial, or adapted for swimming (232, 222, 159). Without direct observations of behavior, Zarenkov (298) suggested that the flattened dactyli and elevated frontal region of the carapace were adaptations, enabling these shrimps to bury themselves and still keep the eyes above the surface. This is almost certainly correct as one species of the genus, *A. dentata,* was observed burrowing into the bottom (78). It seems that the flattened distal segments of the third maxillipeds also could serve as effective burrowing implements.

After reviewing the long-standing controversy concerning the identities of *A. lar* and *A. dentata,* Squires (244) concluded that the two species were distinct. Later, good diagnostic characters were illustrated (246). Care should be taken when examining specimens thought to be *A. dentata* from the northern British Columbia and Alaska coasts, because of the possibility of confusion with another similar species, *A. ovifer.* The two smaller local species, *A. crassa* and *A. levior,* appear closely related. Both have a twisted outer margin of the antennal scale in common, among other characters.

There are apparently 12 known species in the genus (298), six occur on the British Columbia coast. The genus is almost entirely restricted to the North Pacific Ocean, including the Bering and Chukchi seas; *A. dentata* occurs as well in the western Atlantic Ocean. In this Bulletin, members of the genus are termed "argids."

Carapace spines are shown on the drawing of a hypothetical argid (Fig. 13).

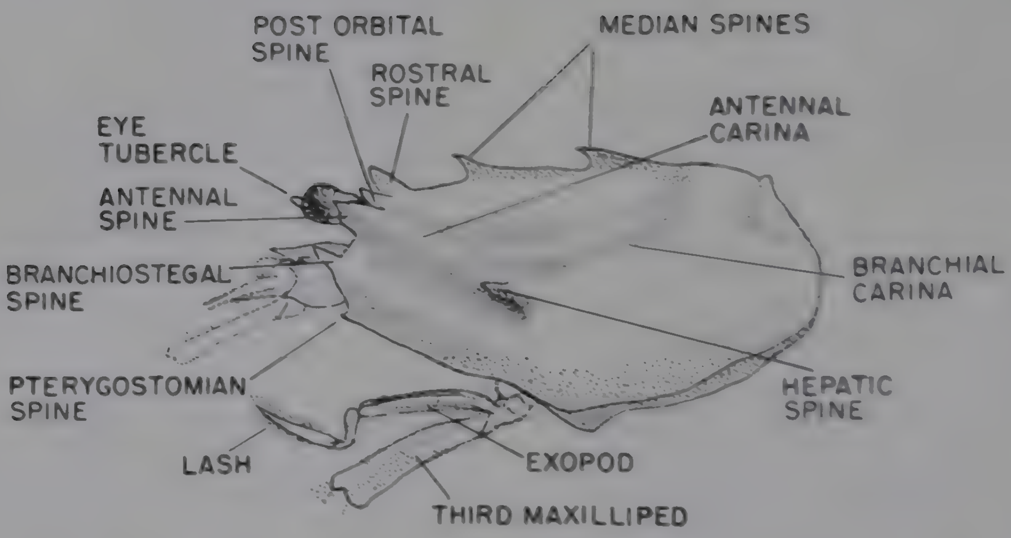
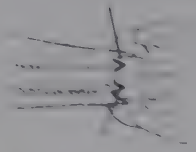

POST ORBITAL SPINE
MEDIAN SPINES
ROSTRAL SPINE
ANTENNAL CARINA
EYE TUBERCLE
ANTENNAL SPINE
BRANCHIOSTEGAL SPINE
BRANCHIAL CARINA
PTERYGOSTOMIAN SPINE
HEPATIC SPINE
LASH
EXOPOD
THIRD MAXILLIPED

FIG. 13. Hypothetical carapace of an argid, showing terms used in species accounts.

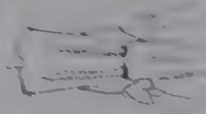
Key to species of genus *Argis*

1 Carapace with 2 median dorsal spines posterior to rostral spine 2

Carapace with 3 or 4 median spines posterior to rostral spine 4



2 Dorsal carinae on sixth abdominal somite extend beyond posterior margin as moderate spines 3



Dorsal carinae on sixth somite not extending beyond posterior margin as spines .... Northern argid, *A. lar* (p. 79)

3 Pleuron of fourth abdominal somite with posterolateral spine; tubercle on inner margin of eyestalk, moderate, rounded tip .... Arctic argid, *A. dentata* (p. 81)

Pleuron of fourth somite lacking posteroventral spine; tubercle on eyestalk prominent, acute tip .... Split-eye argid, *A. ovifer* (p. 83

4 Dorsal carinae on sixth somite extending beyond posterior margin as moderate spines .... Common argid, *A. alaskensis* (p. 85)

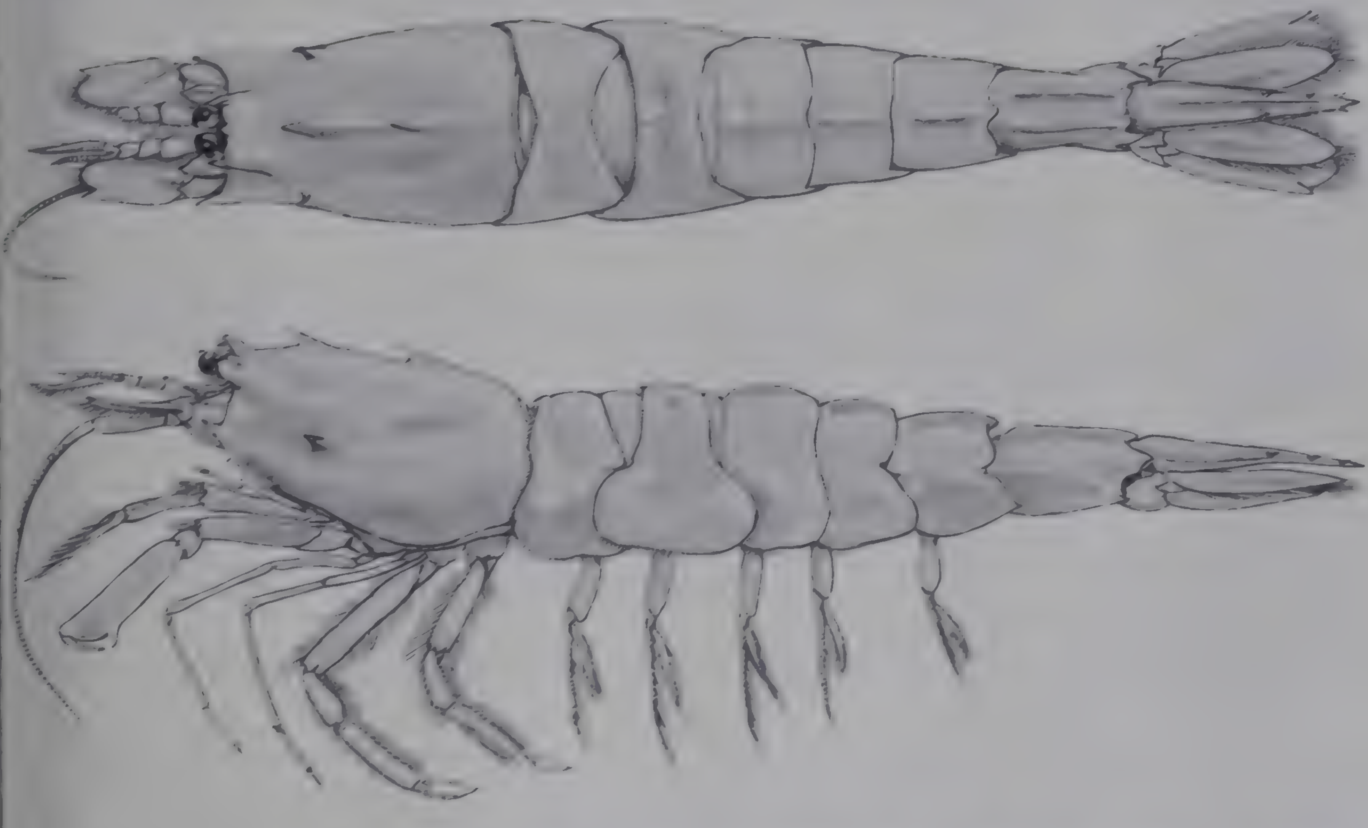
Dorsal carinae on sixth somite not extending beyond posterior margin as spines 5

5 First somite with large median dorsal tubercle; second to fifth somites each with median carina .... Rough argid, *A. crassa* (p. 87)

First somite with small median dorsal tubercle, second to fourth somites lacking carinae, fifth somite with median carina .... Nelson's argid, *A. levior* (p. 89)

NORTHERN ARGID

Argis lar (Owen, 1839)



Description *Female* Moderately stout, depressed. Shell thick, surface generally smooth, some pubescence on lower branchial region of carapace. Rostral spine short, obliquely erect, tip blunt. Carapace spines and carinae: 2 dorsal spines arising from median carina, extending along almost entire carapace, sometimes tubercle behind rostral spine; postorbital and antennal moderate, forming with rostral spine a hoodlike cover; branchiostegal strong, with supporting carina, extending posteriorly beyond hepatic spine; pterygostomian weak; hepatic moderate, with broad base, upper margin extending obliquely to join branchial carina; antennal carina extending from antennal spine, in slight arc to join branchial carina; latter extending almost to posterior margin near median dorsal carina;

depressed areas anterior to hepatic spine, frontal, gastric, and cardiac regions. Eye small, cornea well developed, with moderate tubercle. Antennule: peduncle long, third segment subequal to second; stylocerite short; inner flagellum longer than outer, both extending beyond antennal scale by half their lengths. Antenna: scale short, moderately wide, lamella exceeding scale slightly; basicerite, 2 weak lateral spines; peduncle long; flagellum shorter than body. Third maxilliped: long, slender except antepenultimate segment, setiferous; distal segment flattened, tip blunt; exopod long, with lash. Pereiopods: I about as long as third maxilliped, stout; merus, weak upper distal spine; carpus, weak distal spine, slender, moderately long, 3.5–4.2 average width, fixed finger moderate; dactylus, when flexed, obliquely transverse; II longer than I, slender; chelate; III about as long as II; as slender; dactylus about 0.45 propodus length, tip acute; IV shorter than III, stout, setiferous; dactylus flattened, bent, about 0.67 propodus length, tip acute; V shorter than IV, stouter, except propodus and dactylus, setiferous; dactylus flattened, bent, about 0.75 propodus length, tip acute. Abdomen: dorsal median carina on each of first to fifth somites, that on fifth produced posteriorly as rounded lobe; first somite with sinuous, oblique transverse carina, from anterior margin, close to midline, to lower posterior part of pleuron; on pleuron of second, a faint V-shaped carina; third and fourth each with slightly curved transverse carina extending from median carina to articular knob, then deflected toward the lower anterior margin of pleuron; on fifth, a wide uneven lateral carina, between articular knobs, and faint angled carina from below articular knob to lower anterior margin of pleuron, also moderate posteroventral spine; sixth shorter than telson, with 2 dorsal carinae, extending beyond posterior margin as rounded lobes, prominent lateral carina, from near anterior margin to middle of segment, then curving ventrally, on ventral margin carina flaring laterally and ending as moderate posteroventral spine, and posterolateral margin thickened widely; telson moderately wide, tapering to acute tip, median dorsal sulcus, 3 pairs of dorsolateral spines; uropods about equal, shorter than telson, extending beyond middle pair of dorsoventral spines. *Male* Smaller, more slender than female; distal margin of propodus and dactylus of pereiopod, when flexed, more transverse; dorsal abdominal carinae more prominent, especially on third somite; sometimes pleuron of fourth somite with posterolateral spine (219).

Color Unavailable.

Distinctions *A. lar* is distinguished from the other 2 species occurring locally with 2 median dorsal spines on the carapace, by 2 dorsal carinae on sixth abdominal somite more or less parallel, and not extending beyond posterior margin; median dorsal carina on fifth somite produced posteriorly as rounded lobe; antennal scale, with lamella exceeding spine; uropods about equal.

Maximum lengths Males: carapace 13.6 mm, total 56 mm (219); females: carapace 21.5 mm, total 79 mm (219).

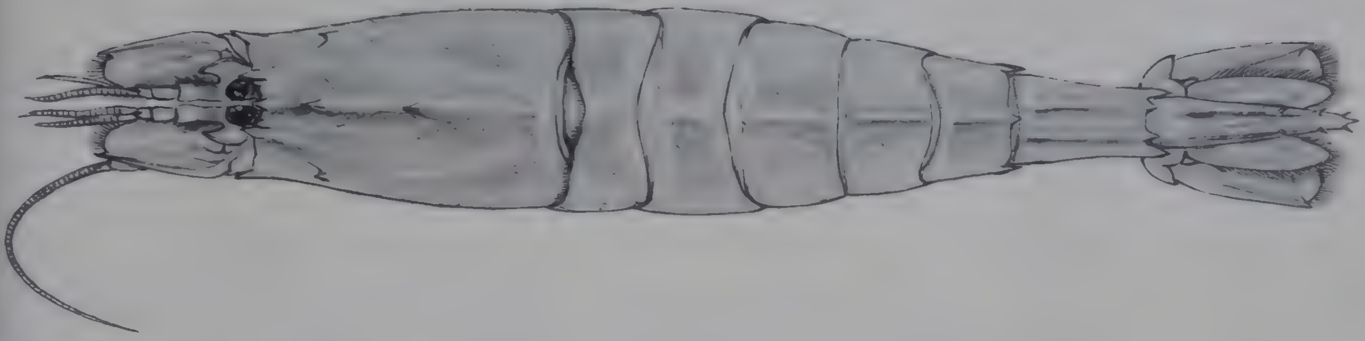
Range Chukchi Sea (178, 174), Bering Sea (219) to Strait of Georgia; Okhotsk Sea (265), Sea of Japan, to Peter the Great Bay; 10–280 m (265). *A. lar* is restricted to waters adjacent to western North America and eastern Asia (244).

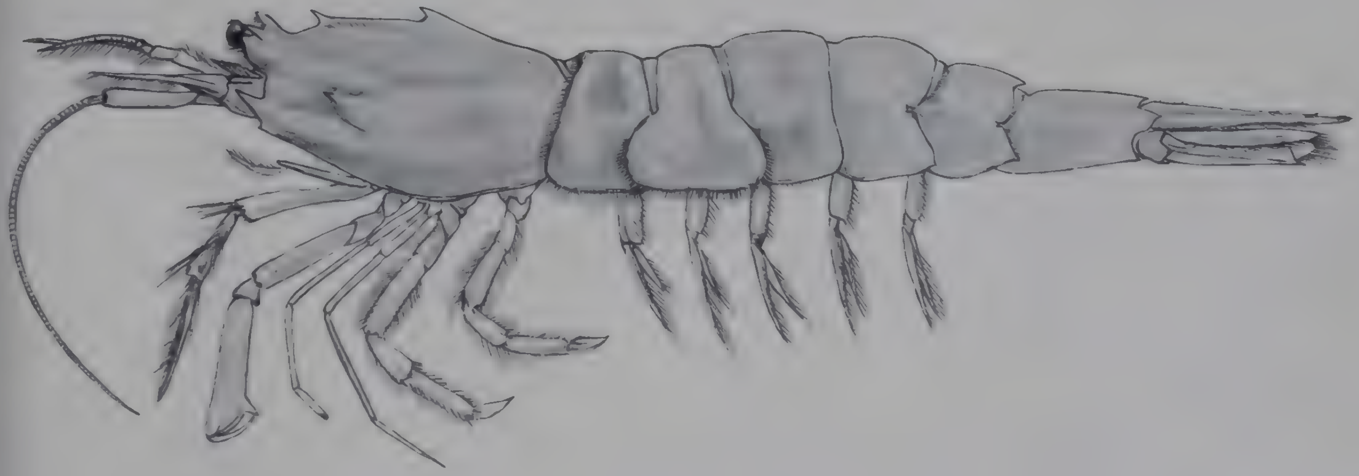
The first published record of this shrimp on the British Columbia coast (238) was collected near Shoal Harbour, at 18–36 m in 1926 or 1927. There is considerable doubt that specimens belonged to *A. lar,* as it was stated that the shrimp agreed in every respect with the description given (presumably by Rathbun 1904), except that the keels were not as high on carinae of abdominal segments, and there was a single spine between the median spine and the lateral carina of the carapace. It is more likely that they were in fact *Metacrangon munita,* or even *Mesocrangon intermedia.* A male, 7.6 mm carapace length, collected by I. M. Cowan at an unspecified locality, was identified by the present author as *A. lar.* Other species in the container, including *Heptacarpus brevirostris, H. stylus,* and *Crangon nigricauda,* indicate that the collection was made in relatively shallow water. Dr Cowan expresses the opinion that the specimen was probably collected in Plumper Sound in 1962 or 1963. There is no subsequent record of the species.

Biology and economics Relatively little information is available. An estimate of egg numbers was 980, and egg dimensions were 1.4 × 1.15 mm (298). Two stages of a larva from plankton collections in the Okhotsk Sea were identified as *A. lar;* reportedly the larval life is less than a month (176). A parasite is the branchial isopod, *Argeia pugettensis* (225).

ARCTIC ARGID

Argis dentata (Rathbun, 1902)





Description Body stout, depressed. Shell thick, fine pubescence over dorsolateral regions of carapace and rostrum, rest finely pitted. Rostral spine short, obliquely erect, tip acute. Carapace spines and carinae: postorbital and antennal weak to moderate, forming with rostral spine a hoodlike cover; 2 dorsal spines, arising from median carina extending from base of rostral spine to almost posterior margin of carapace; branchiostegal very strong, with supporting carina, curving posteriorly to position under base of hepatic spine; pterygostomian weak; hepatic strong, with supporting carina, curved upward to meet branchial carina; antennal carina curving posteriorly from base of antennal spine, with some weakening above hepatic spine, to join branchial carina; latter arched slightly, reaching posterior margin; depressed areas in frontal and gastric regions and ventral to antennal carina, anterior to hepatic spine. Eye small, cornea well developed, slight tubercle. Antennule:

peduncle long, third segment subequal to second; stylocerite short; inner flagellum slightly longer, both overreaching antennal scale by half, or more, of their lengths. Antenna: scale short, moderately wide, spine exceeds lamella; basicerite, 2 weak to moderate lateral spines; peduncle long; flagellum shorter than body. Third maxilliped: long, moderately stout, setiferous; strong distal spine on antepenultimate segment; distal segment flattened, trowel-like, tip rounded; exopod with lash. Pereiopods: I about as long as maxilliped, stouter, propodus long, slender, 4.5–5.0 average width, fixed finger moderate; dactylus, when flexed, obliquely transverse; II about as long as I, very slender; chelate; III longer than II, as slender; dactylus about 0.45 propodus length, tip acute; IV shorter than III, stout, setiferous; dactylus flattened, bent, about 0.6 propodus length, tip acute; V shorter than IV, as stout, setiferous; dactylus flattened, bent, about 0.68 propodus length, tip acute. Abdomen: first to fifth somites each with dorsal median carina; that of fifth extended posteriorly as blunt spine, those of third and fourth may or may not be extended; most dorsolateral surfaces of first to third somites depressed and pubescent; on fourth, triangular depressed area in lower anterior portion of pleuron; depression on fifth between median carina and curved carina between articular knobs, lower patch on pleuron; ventral margins of pleura of first to fourth somites straight or slightly concave; pleuron of fourth with weak posteroventral spine; fifth with anterior transverse carina, bearing fine setae, and adjacent parallel sulcus, also moderate posterolateral spine flared slightly; sixth with 2 prominent dorsal carinae, proximal ends almost meet anterior transverse carina, bearing fringe of setae, and carinae extending beyond posterior margin as moderate spines, also short, curved lateral carina from articular knob posteriorly to beyond middle of somite, and moderate posteroventral spine; telson longer than sixth, moderately wide, tapering to acute tip, wide dorsal sulcus, 3 pairs of dorsoventral spines, middle pair closer to distal than to proximal pair; dense setae on lateral margins; outer uropod extends to middle dorsolateral spine of telson, and shorter than inner; both shorter than telson.

Remarks For sake of clarity, lateral setae on telson are omitted from above illustration of dorsal view.

Color Unavailable.

Distinctions *A. dentata* can be separated from *A. lar* and *A. ovifer*, the other 2 recorded species with 2 dorsal spines on the carapace, by 2 dorsal carinae on the sixth abdominal somite, more or less parallel, and extending beyond posterior margin as moderate spines; presence of posterolateral spine on pleuron of fourth somite; dense setae on lateral margins of telson; slender, long propodus of pereiopod I, 4.5–5.0 times its average width.

Maximum lengths Males: carapace 10.6 mm, total 46 mm; females: carapace 21.8 mm, total 83 mm.

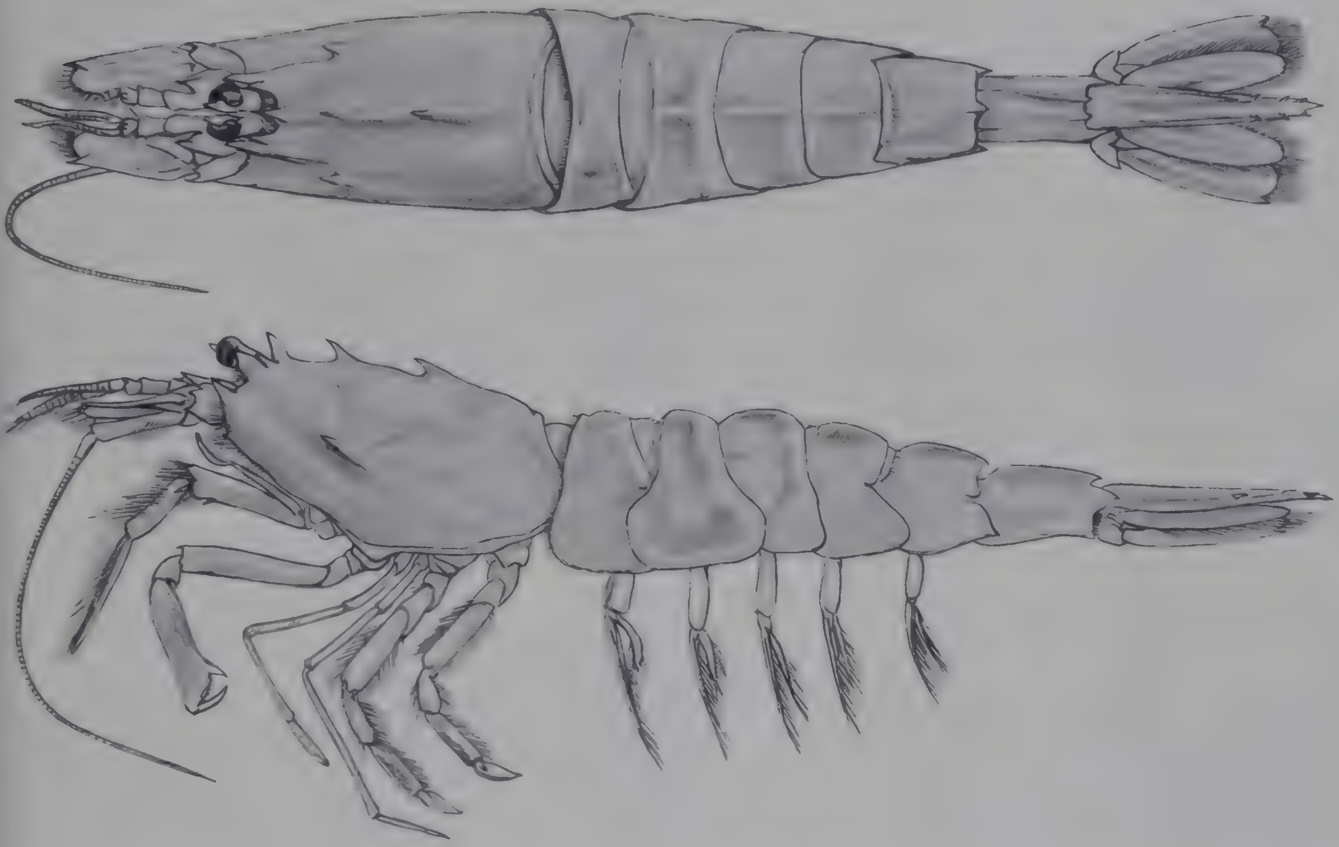
Range Anadyr Gulf, Bering Sea; Okhotsk Sea; Sea of Japan, to Peter the Great Bay (265); Pribilof Islands (219) to Gulf of Georgia and San Juan Islands (159). Coronation Gulf (110), Foxe Basin, Greenland to Nova Scotia (247); intertidal (250, 43) to 2090 m (266).

First record on the west coast of Canada was a specimen caught in Work Canal, July 1906 (258).

Biology and economics *A. dentata* is more common along the north coast of the province, particularly in inlets. In the Gulf of St. Lawrence this shrimp is most abundant at bottom temperatures -1.0 to 3.0°C; there is a preference for sand and gravel bottoms (78). During the day, individuals in an aquarium were seen to bury themselves (78). Also in the Gulf, it was demonstrated that *A. dentata* is a protandrous hermaphrodite (97). An egg count of 246, and egg dimensions of 2.25 × 2.25 mm were reported (298). First and second larval stages and the megalopa were described from plankton samples collected in Ungava Bay, northern Quebec (248). A later description (143) of the first stage larva, hatched from a female in the Gulf of Alaska, differs from the western Atlantic larva only in minor details. The branchial isopod, *Argeia pugettensis*, is a parasite in Pacific waters (225, 100). This shrimp was collected at 1 intertidal station and 7 trawl stations (46–121 m) in southeastern Alaska (250, 43).

SPLIT-EYE ARGID

Argis ovifer (Rathbun, 1902)



Description Moderately stout, depressed. Shell thick, partly smooth, pubescence on carapace and abdomen. Rostral spine long, suberect, separated from postorbital spine, tip blunt. Carapace spines and carinae: 2 moderate dorsal spines arising from distinct median carina, from rostral spine almost to posterior margin; postorbital moderate, antennal long, acute, reaching cornea of eye, these separated by deep incision, and provide little cover for eye; branchiostegal strong, supported by carina, extending obliquely to middle of lower branchial region; pterygostomian weak; hepatic moderate, from wide base, upper margin as weak carina running obliquely to branchial carina, and lower margin extending obliquely to meet carina from branchiostegal spine; prominent sinuous antennal carina extends from antennal spine to meet branchial carina; latter ascending toward cardiac region; generally, carinae on carapace border depressed pubescent areas. Eye moderately large, cornea well developed, tubercle strong, from swollen conical base, separating inner margin of cornea, to prominent acute tip. Antennule: peduncle moderately long, third segment subequal to second, former with dorsal distal spine; stylocerite short, flagella about equal, and overreach antennal scale by about half their lengths. Antenna: short, moderately wide, spine exceeds lamella; basicerite, 2 weak lateral spines; peduncle long, flagellum shorter than body. Third maxilliped: long, moderately stout, setiferous, antepenultimate segment stouter distally, moderate lower spine adjacent to distal margin, distal segment flattened; exopod long, with lash. Pereiopods: I as long as third maxilliped, stout; merus, weak upper distal spine; carpus, distal spine; propodus slender, moderately long, 3.5–4.5 average width, fixed finger moderate; dactylus, when flexed, obliquely transverse; II as long as I, slender; chelate; III longer than II, as slender; dactylus about 0.45 propodus length, tip acute; IV shorter than III, stout, setiferous; dactylus flattened, bent, about 0.75 propodus length, tip acute; V shorter than IV, less stout; dactylus flattened, bent, about 0.75 propodus length, tip acute. Abdomen: dorsal median carina on each of first to fifth somites, that on fifth produced posteriorly as acute spine; dorsolateral surfaces of first 5 somites with irregular protuberances and ridges; on first, 2 depressions, upper bordered by thickened lateral margins and median carina, lower bordered by lateral margins, ventral margin, and irregular lateral ridge; on second, most of surface depressed, marked by median carina, thickened lateral margins, both deflected and converging above ventral margin; similar sculpturing on third, fourth, and fifth, except on last, depression bordered by ventral margin of pleuron; also, irregular lateral ridges at level of articular knobs on fourth and fifth; fifth with strong posteroventral spine; sixth with 2 prominent dorsal carinae converging posteriorly, extending beyond posterior margin as acute spines, curved lateral carina, weak posteroventral spine, flared slightly; telson moderately wide, tapering to acute tip, median dorsal sulcus, 3 pairs dorsolateral spines; inner uropod longer than outer, former extending to middle pair of spines on telson.

Remarks A tubercle is present on eyestalks of all local argids, and effects some separation of the inner surface of the cornea. The author believes that *A. ovifer* has the most conspicuous separation of the inner cornea and so merits the common name "split-eye" argid. Rathbun stated that the tubercle is more prominent on *A ovifer* than on *A. lar* or *A dentata* (219).

Color Background light buff over most of body and some appendages, large, finely mottled, brown area blending with background on posterior half of carapace, fine brown to black dots bordering ventral and anterolateral margins, including rostral spine; irregular, diagonal brown bars on second to fourth somites, areas of same hue on lower parts of pleura of fourth and fifth somites, on lower lateral and posterior regions of sixth somite; 2 light green patches on fifth pleuron; wide transverse bar dorsally on telson and uropods, brown distal setae; pleopods, third maxilliped, and pereiopods mainly background color, carpus and chela of pereiopod I and merus of pereiopod IV with fine brown spots; pinkish on dactyli of pereiopods IV and V, on antennal flagellum, and on flagella of antennule (Plate 5B).

Distinctions Separated from *A. lar,* and particularly *A. dentata,* by prominent tubercle on eyestalk with swollen base separating cornea, acute tip; suberect rostral spine, separated from postorbital spine; dorsal carinae on sixth somite converging, often not as abruptly as shown in the dorsal view (p. 83).

Maximum lengths Males: carapace 9.9 mm, total 38 mm; females: carapace 17.6 mm, total 67 mm.

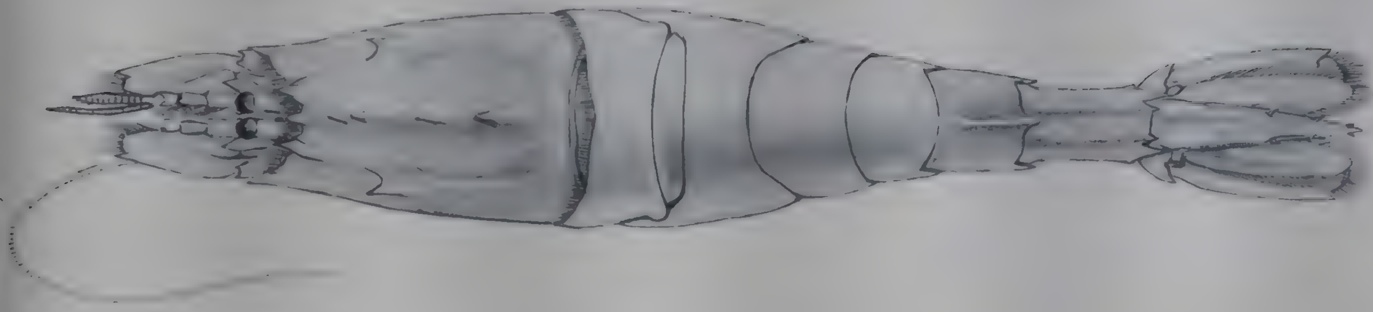
Range North of Pribilof Islands, Bering Sea (219) to Queen Charlotte Sound; Okhotsk Sea (266); 102–673 m (217).

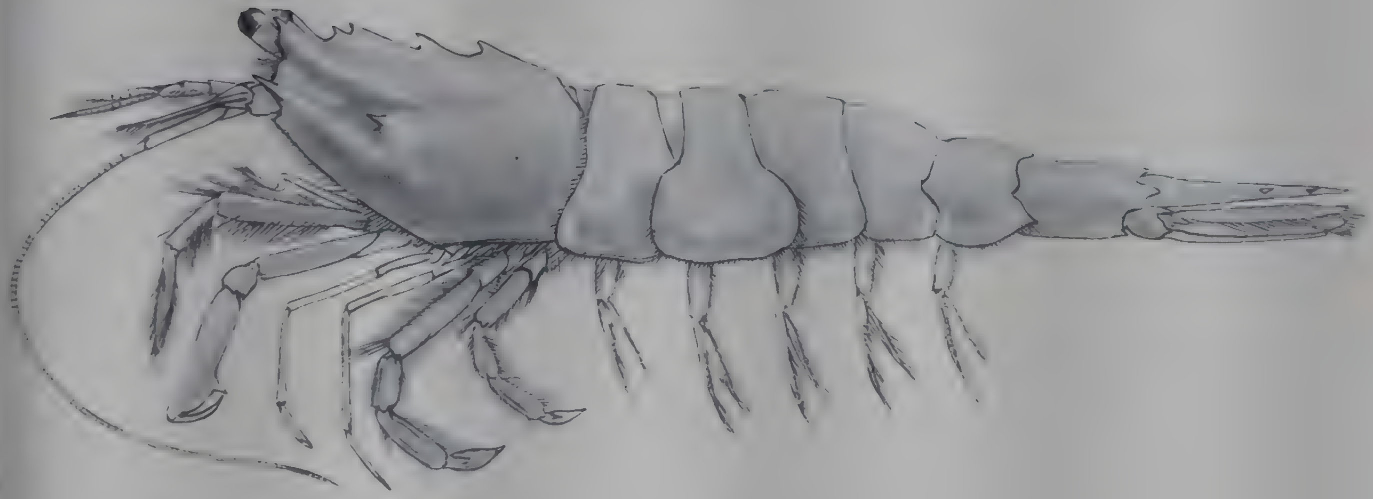
The first known capture of *A ovifer* on the west coast of Canada was by *G. B. Reed* trawling in Queen Charlotte Sound (51.22N, 129.03W), at 219–223 m, Feb. 23, 1963.

Biology and economics In addition to the above record of 2 specimens, 3 were caught off La Perouse Bank, at 207–218 m, Feb. 8, 1972, and in Queen Charlotte Sound, April 1974. Reported egg dimensions were 2.0 × 1.15 mm (298). A parasite is the branchial isopod, *Argeia pugettensis* (225).

COMMON ARGID

Argis alaskensis (Kingsley, 1882)





Description Body moderately stout, depressed. Shell thin, pubescence on lower branchial region of carapace, sparse on abdomen. Rostral spine short, suberect, tip acute. Carapace spines and carinae: postorbital and antennal moderate, forming with rostral spine a hoodlike cover; 3 large dorsal spines fairly evenly spaced, and 1 small spine posterior to rostral spine; slight median carina; branchiostegal very strong, reaches to or beyond basicerite of antenna, with supporting carina, curved posteriorly to position under hepatic spine; pterygostomian weak; hepatic strong, with triangular supporting base, dorsal edge of which joins branchial carina; antennal carina curving obliquely and posteriorly from base of antennal spine, with some weakening above hepatic spine, to join branchial carina; latter arched slightly, and ends ahead of posterior margin; depressed areas in frontal, gastric, and cardiac regions, and ventral to antennal carina, anterior to hepatic spine. Eye small, cornea well developed, moderate tubercle. Antennule: peduncle moderately long, third segment subequal to second; stylocerite short; inner flagellum slightly longer than outer, both overreach antennal scale. Antenna: scale short, moderately wide, spine exceeds lamella; basicerite, 2 weak lateral spines, peduncle long; flagellum shorter than body. Third maxilliped: long, moderately stout, setiferous; penultimate and distal segments flattened, latter more so, tip blunt; exopod with lash. Pereiopods: I about as long as third maxilliped, stout; merus, weak distal spine; carpus, weak distal spine, propodus slender, about 4.0–4.5 average width, fixed finger moderate; dactylus, when flexed, longitudinally oblique; II shorter than I, very slender; chelate; III slightly longer than II, slightly stouter; dactylus about 0.42 propodus length, tip acute; IV about as long as III, stout, setiferous; dactylus flattened, about 0.78 propodus length, tip acute; V shorter than IV, more slender; setiferous;

dactylus flattened, about 0.70 propodus length, tip acute. Abdomen: indication on male of dorsal median carina on each of first to third somites, smooth on female; fourth with faint carina, and fifth with distinct median carina, separated from anterior margin by transverse sulcus, and extending beyond posterior margin as strong spine; depressed areas on dorsolateral surfaces of first to fifth somites; posterolateral margins of fourth and fifth widely recessed at articular knobs; former with posteroventral spine, weak or obsolescent; fifth, posterolateral spine strong, giving slight flare; sixth with 2 distinct dorsal carinae, produced beyond posterior margin as moderate spines, with strong posteroventral spine, flared slightly; telson longer than sixth, moderately wide, tapering to acute tip, wide dorsal sulcus, 2 pairs dorsolateral spines in distal half of telson; outer uropod wider and shorter than inner, both shorter than telson.

Color Background color milkish to buff; on carapace, brown to black spots form diagonal bars and bands, blend with background, and border ventral and anterolateral margins; on abdomen, brown to gray-brown patches on dorsal and lateral surfaces, on third and fourth somites these border light diagonal bars; red-orange areas on fifth and sixth somites, telson, and uropods; ventral margins of first and second pleura, and pereiopods IV and V cerise; light gray-brown, overlaid with fine brown spots, on third maxilliped, pereiopod I, and pleopods (Plate 4C).

Distinctions Distinguished by 3 or 4 median dorsal spines on carapace, posterior to rostral spine; on sixth somite, prominent dorsal carinae extend beyond posterior margin as moderate spines; very strong branchiostegal spine, extends to or beyond lateral spines on basicerite of antenna.

Maximum lengths Males: carapace 11.2 mm, total 44 mm (219); females: carapace 17.8 mm, total 67 mm.

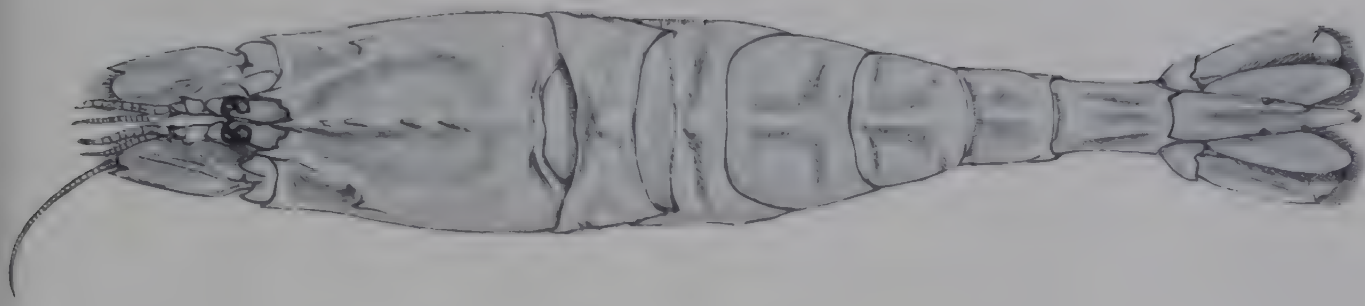
Range Pribilof Islands, Bering Sea to Oregon (219); 18–221 m (207, 219).

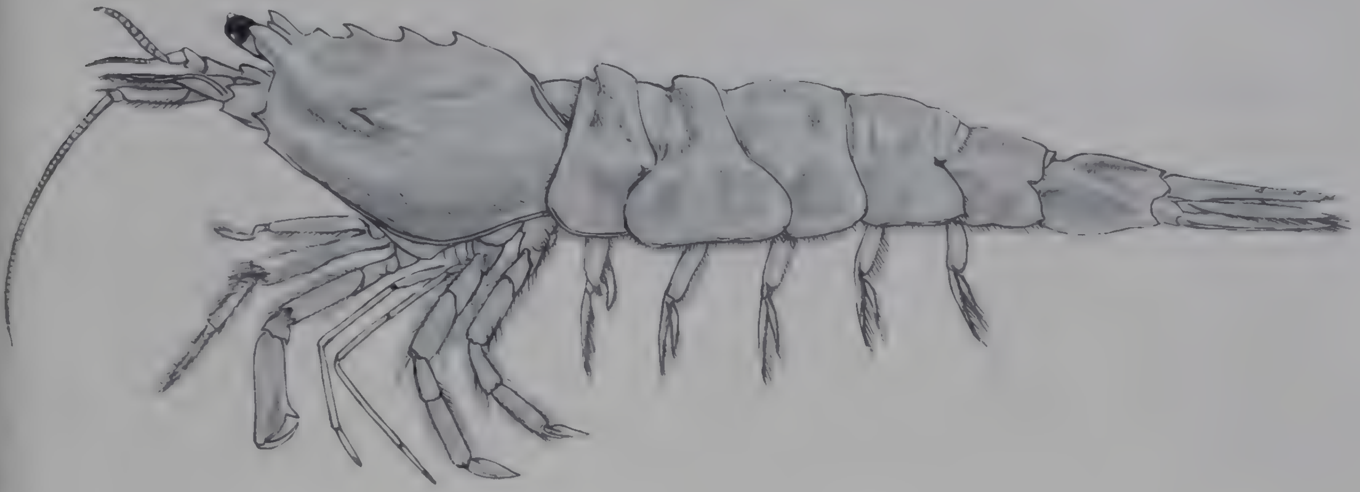
The first published record of the species on the British Columbia coast was by Taylor (258), who stated, “not uncommon in Departure Bay.”

Biology and economics This species is the most common argid occurring in local waters. Most specimens were collected within the depth range, 46–128 m. Females, 9.7–16.7 mm carapace length, were ovigerous during February, May, September, and October. *A. alaskensis* is parasitized by the branchial isopod, *Argeia pugettensis* (225, 100).

ROUGH ARGID

Argis crassa (Rathbun, 1899)





Description Body stout, depressed. Shell thick, pubescence over most of carapace, and patches on abdomen. Rostral spine short, suberect, tip blunt. Carapace spines and carinae: postorbital moderate; antennal strong, forms with rostral spine a hoodlike cover; 3 strong dorsal spines and a smaller one posterior to rostral spine, all arising from median carina extending almost entire length of carapace; branchiostegal strong, with supporting carina, curved posteriorly to position under base of hepatic spine; pterygostomian weak; hepatic strong, with supporting carina curved upward to meet branchial carina; antennal carina curving posteriorly from base of antennal spine, with some weakening above hepatic spine, to join branchial carina; latter arched slightly, and extending toward median dorsal line; depressed areas in frontal and gastric regions and anterior to hepatic spine. Eye small, cornea well developed, tubercle strong, with swollen base, separating cornea. Antennule: peduncle moderately long, second segment longer than third; stylocerite short; inner flagellum about as long as outer, both extending beyond antennal scale. Antenna: scale short, wide, spine exceeding lamella, outer margin twisted at proximal end; basicerite, moderate upper lateral spine, lower weak; peduncle long; flagellum shorter than body. Third maxilliped: long, moderately stout, setiferous; distal segment flattened; exopod long, with lash. Pereiopods: I about as long as third maxilliped, stout; carpus, distal spine; propodus moderately long, slender, 3.2–4.0 average width, fixed finger moderate; dactylus, when flexed, obliquely transverse; II longer than I, very slender; chelate; III about as long as II, as slender; dactylus about 0.5 propodus length, tip acute; IV shorter than III, stout, setiferous; dactylus flattened, bent, about 0.65 propodus length, tip acute; V shorter than IV, less stout, setiferous; dactylus flattened, about 0.67 propodus length, tip acute. Abdomen:

first somite with large median dorsal tubercle directed anteriorly; second with short wide carina directed anteriorly, deep depressed area on each side; similar wide carina on third, but longer, lower, also 2 wide transverse carinae; prominent wide carina, shorter than somite, on each of fourth and fifth somites; on fourth, 2 wide transverse carinae; pleura of fourth and fifth each with weak posterolateral spine; fifth also with deep anterior transverse sulcus, lateral carina from articular knob slightly curved; sixth shorter than telson, with 2 blunt carinae, shorter than somite, converging posteriorly, with wide lateral carina from articular knob curving toward posteroventral angle, also on ventral margin, carina flaring laterally and ending in moderate posteroventral spine; telson moderately wide, tapering to acute tip, median dorsal sulcus, 2 pairs dorsolateral spines, both in distal half of telson; inner uropod longer, and shorter or as long as telson.

Color Carapace with diagonal bars of gray, grayish green, blackish green, and black meeting a black area over most of lower branchial region; 2 broken black vertical lines in branchiostegal and antennal regions; 3 main dorsal spines on carapace, each with lateral yellow spot. Black spots on basicerite, outer margin of antennal scale, and peduncle, and antennular peduncle; third maxilliped and pereiopods, from colorless background with black spots and streaks, black and buff to yellow bands, to almost completely black. Most of upper lateral surfaces of first to fourth abdominal somites greenish gray; on these somites black patches bordering ventral margins and on each, 1 large and several smaller yellow spots; on fifth somite ventral yellow spots, most of lateral surface mottled, streaked with black; sixth mainly black with buff to yellow spots and streaks; telson and uropods mainly buff to yellow, with black blotches and streaks; black and brown spots on protopodites of pleopods, exopods with brown spots (Plate 1D).

Distinctions *A. crassa* is known by 3 large median dorsal spines on the carapace, and 1 small spine posterior to rostral spine; a large median dorsal tubercle on first somite, and short wide dorsal carina on each of second to fifth somites; weak posterolateral spine on fourth pleuron; pubescence over most of carapace, and on depressed areas on abdominal somites.

Maximum lengths Males: carapace 9.8 mm, total 40 mm; females: carapace 13.9 mm, total 56 mm.

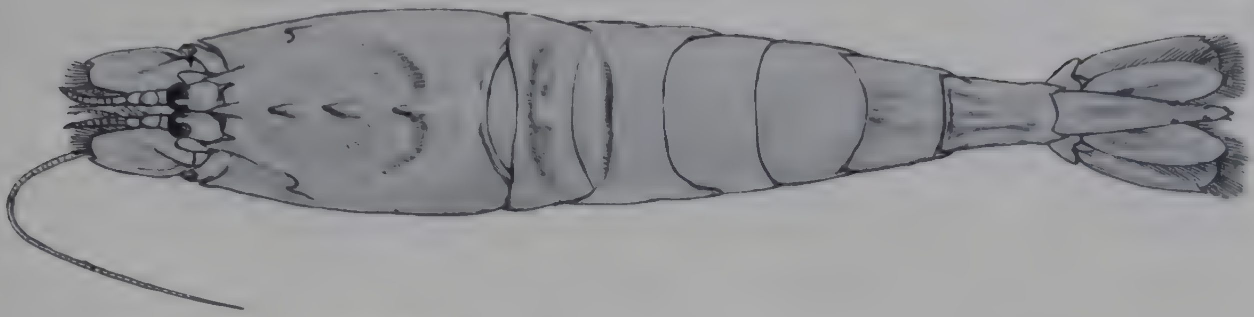
Range St. Lawrence Island, Bering Sea; Okhotsk Sea; to Maritime Territory, Sea of Japan (265); Aleutian Islands (219) to San Juan Islands (159); 4–125 m (265).

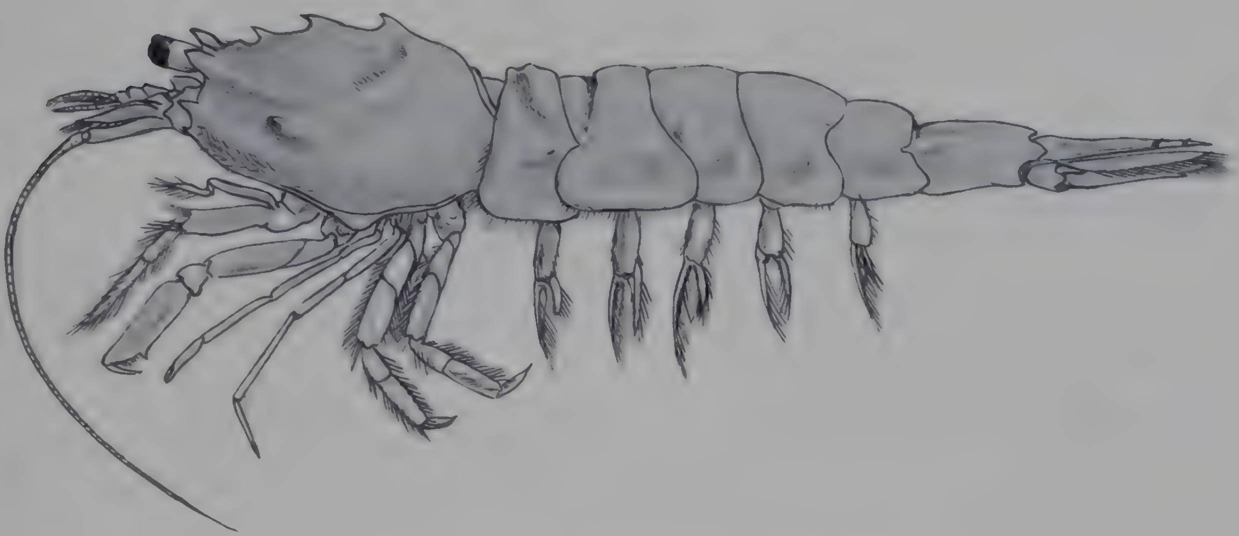
The first reference to this species in British Columbia waters was by Taylor (258), who dredged it in Burrard Inlet and at Namu.

Biology and economics *A. crassa* is uncommon in local waters. Specimens have been collected in Howe Sound, and at 3 localities in the Queen Charlotte Islands. A parasite is the branchial isopod *Argeia pugettensis* (255). Reportedly, the egg count was 448, and egg dimensions were 1.5 × 1.05 mm (298). A description (143) of the first stage larva, as hatched from a female, has a comment that a planktonic larva, identified earlier (176) as *A. crassa*, either belongs to a different species or is a later stage larva of *A. crassa*.

NELSON'S ARGID

Argis levior (Rathbun, 1902)





Description Body stout, depressed. Shell thick, pubescence over most of carapace, and patches in depressed areas on abdomen. Rostral spine short, obliquely erect, tip blunt. Carapace spines and carinae: postorbital moderate, antennal strong, forming with rostral spine a hoodlike cover; 3 strong dorsal spines, a smaller one posterior to rostral spine, all arising from median carina extending almost entire length of carapace; branchiostegal strong, with supporting carina, curved posteriorly to position under hepatic spine; pterygostomian moderate; hepatic strong, with short supporting carina; antennal carina curving posteriorly from base of antennal spine, weakening above hepatic spine before reaching branchial carina; latter arching slightly and extending toward posterior margin; depressed areas in frontal and gastric regions and anterior to hepatic spine. Eye small, cornea well developed; tubercle moderate, with swollen base, separating cornea. Antennule: peduncle moderately long, second segment longer than third; stylocerite short; outer flagellum longer than inner, both extending beyond antennal scale. Antenna: scale short, moderately wide, spine exceeding lamella slightly, outer margin convex, twisted; basicerite, moderate upper and lower lateral lobes; peduncle long; flagellum shorter than body. Third maxilliped: moderately long, moderately stout, setiferous; distal segment flattened; exopod moderately long, with lash. Pereiopods: I longer than third maxilliped, stout; propodus slender, moderately long, 3.5–4.5 average width, fixed finger moderate; dactylus, when flexed, obliquely longitudinal; II about as long as I, very slender; chelate; III longer than II, as slender; dactylus about 0.45 propodus length, tip acute; IV shorter than III, stout, setiferous; dactylus flattened, curved, about 0.55 propodus length, tip acute; V slightly shorter than IV, less stout, setiferous; flattened, curved, about 0.75 propodus length, tip acute. Abdomen: low dorsal median tubercle on first somite, oblique transverse sulcus anterior to sulcus extending to posterolateral margin; second somite with transverse furrow and adjacent margin bearing setae; pleura of second to fifth with depressed pubescent areas; pleuron of fourth sometimes with weak posterolateral spine; fifth with low, wide dorsal carina, posterolateral angle obtuse; sixth shorter than telson, with 2 low, wide dorsal carinae converging posteriorly, lateral carina curving from articular knob toward obtuse slightly flared posteroventral angle; telson moderately wide, dorsal sulcus, 3 pairs dorsolateral spines; inner uropod longer, reaching tip of telson.

Remarks This shrimp was given its common name after A. Nelson Yates, the author's long-time assistant. The transverse furrow on the second abdominal somite is thought to be an adaptation, enabling assumption of the defensive cataleptic position, as in *Metacrangon spinosissima* (p. 115), and *Lebbeus schrencki* (p. 185).

Color Unavailable.

Distinctions Distinguished by 3 large dorsal spines on carapace, and 1 small spine posterior to rostral spine; a median dorsal tubercle on first abdominal somite; on second somite, a transverse furrow with a setose posterior margin; low broad dorsal carina on fifth somite.

Maximum lengths Males: lengths unavailable; females: carapace 12.4 mm, total 47.0 mm (U.S. National Museum 25256).

Range Aleutian Islands (217) to Shelter Cove, CA (281); 18–77 m (219).

First caught on the British Columbia coast by the *Albatross* northwest of Barkley Sound at 62 m, Sept. 25, 1888 (station 2880) (219).

Biology and economics Rathbun's statement (219) that this species is more rare than *A. crassa* has been borne out by the paucity of records in local waters. Two females were dredged west of Nahwitti Bay, north end of Vancouver Island, at 22–27 m, on a bottom of coarse sand, boulders, and shell (Cowan collection).

Genus *Sclerocrangon* G. O. Sars, 1883

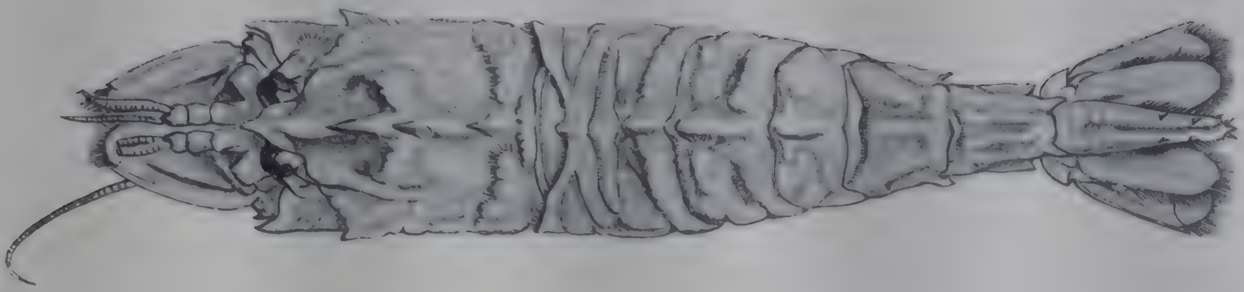
Body stout, depressed. Shell thick, surface rough and heavily sculptured. Carapace with 3 or more median dorsal spines. Fourth and fifth pereiopods much stouter than second and third, setiferous. Most pleura of abdominal somites generally with ventral spines. Endopods of pleopods markedly shorter than exopods. Second pleopod of male with endopod considerably smaller than appendix masculina.

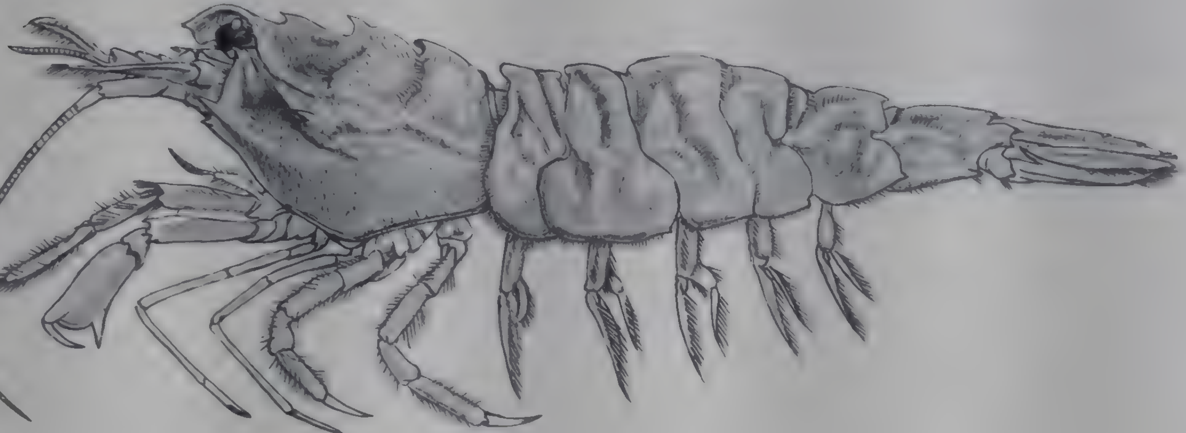
These moderate to large shrimps occur in the Arctic Ocean and in the North Pacific and North Atlantic oceans. Of the six or seven known species, one, *S. boreas,* is circumboreal. Lack of a larval life appears to be a characteristic of the genus (176). The young resemble adults at hatching and for a while may remain on the female. This phenomenon of direct development is considered advantageous for aquaculture (85).

One species is known from British Columbia waters.

SCULPTURED SHRIMP

Sclerocrangon boreas (Phipps, 1774)





Description Body stout, depressed. Shell thick, surface rough, heavily sculptured, pubescent over most of body. Rostrum short, 0.25–0.33 carapace length, arched over eye, then descending, dorsally converging to blunt tip, median dorsal sulcus, deep, narrow, ventral keel. Carapace spines and carinae: 3 strong dorsal spines, if 4, extra arises from base of middle spine; short oblique carina, having 5 or 6 lobes or tubercles, extending from middle dorsal spine, joining fine carina, extending anteriorly to lateral margin of rostrum; suborbital weak, rounded; antennal moderate; branchiostegal strong, with supporting carina, flared somewhat; pterygostomian weak to moderate; heavy tuberculated oblique carina extending from point posterior to antennal spine to strong hepatic spine; posterior to hepatic spine, heavy, tuberculated branchial carina arching to near posterior margin; short, curved, tuberculated carina lies under the hepatic spine and branchial carina; at about posterior third of carapace, heavy, tuberculated, oblique carina branches toward the dorsal midline, between the posterior margin and the base of the posterior dorsal spine; frontal margin of carapace between antennal and branchiostegal spines, elevated and thickened; most of gastric and cardiac regions depressed. Eye small, cornea well developed, moderate tubercle. Antennule: peduncle long, third segment subequal to second, distal dorsal spine on third segment; stylocerite short, lamellar, lateral margin thickened, with blunt distal spine; inner flagellum longer than outer, both extending beyond antennal scale. Antenna: scale wide, outer margin convex, lamella exceeding spine; basicerite, strong upper blunt lateral spine, lower weak spine; peduncle long; flagellum shorter than body. Third maxilliped: long, stout, setiferous; penultimate and distal segments flattened, paddlelike; tip broadly rounded; exopod short, with lash. Pereiopods: I about as long as third maxilliped, very stout; merus, 1 distal spine; carpus, 2 distal spines; propodus oblong, length 2.3–2.7 average width, fixed finger strong, stout; dactylus, when flexed, obliquely transverse; II longer than I, slender; chelate; III as long as or slightly longer than II, about as slender; dactylus about 0.3 propodus length, tip acute; IV about as long as III, much stouter, setiferous; dactylus moderately stout, about 0.66 propodus length, tip acute; V shorter than IV, as stout, setiferous; dactylus moderately stout, 0.72 carapace length, tip acute. Abdomen: wide, heavy, dorsal carina on each of first to fifth somites, that on first produced anteriorly as prominent lobe, that on fifth produced posteriorly as slight lobe; median carina of second divided in 2, posterior part more prominent; those of third and fifth notched anteriorly; dorsal posterior margins of first to fourth notched medially; 2 carinae on pleuron of first converging transversely, adjacent to median carina; posterolateral margins of second to fifth elevated as wide, tuberculated carinae, adjacent to transverse sulci and confluent with dorsal carinae; pleura of first to fifth somites with raised ventral margins, also ventral margin of sixth flaring laterally, ending in moderate spine; pleura of second to fourth with weak posteroventral spines; posteroventral sector of fifth armed with weak spine, flaring laterally; sixth shorter than telson, 2 dorsal median carinae, reaching posterior margin, and with arched, tuberculated lateral carina; telson moderately wide, tapering to acute tip, median dorsal sulcus, 2 pairs dorsolateral spines in distal third; inner uropod slightly longer than outer, both may or may not reach tip of telson.

Remarks There are reports (244, 245) of variations in the morphology of the species. Specimens from British Columbia are fairly uniform with respect to dorsal carapace spines, lengths of branchiostegal and pterygostomian spines, and spines on the pleura of abdominal somites.

Color Bright red, marked with spots of reddish brown (222). Brown and tan, with a few flecks of chalky white, green, and dull yellow (174).

Distinctions Notable for stout body and thick shell, with intricate sculpturing and general pubescence. May be separated from saddle-back shrimp by 3 dorsal carapace spines (middle 1 may be bifurcated); antennal scale with convex outer margin, and lamella exceeding spine; normally with posteroventral spines on pleura of second to fifth abdominal somites.

Maximum lengths Males: carapace 32.0 mm, total 110 mm (219); females: carapace 27.4 mm, total 108 mm.

Range Chukchi Sea (174); Bering Sea (219) to Bare Island, Washington (168); Okhotsk Sea; Sea of Japan, to Maritime Territory (265); arctic Canada, south to Cape Cod (221); North Atlantic Ocean and arctic Europe, Novaya Zemla, Spitsbergen, Iceland, Greenland, to Faroe Islands and northern Norway (247); 0–366 m (221).

The first known collection of *S. boreas* on the British Columbia coast was in Dean Channel, at 3–6 m, July 20, 1951 (153).

Biology and economics The species appears to be more common along the north coast of the province. Specimens were collected intertidally in and near Prince William Sound, during June and July 1961, at temperatures and salinities, 9.6–14.3°C and 14.3–20.5‰, respectively (43, 250). *S. boreas* was observed to burrow in an aquarium (298). Encrusting bryozoans, barnacles, and tube worms were found on the shell (174, 298). A parasite is the marine leech, *Crangonobdella murmanica* Selensky (174). An egg count of 448, and egg dimensions of 2.75 × 2.85 mm were reported (298).

Genus *Rhynocrangon* Zarenkov, 1965

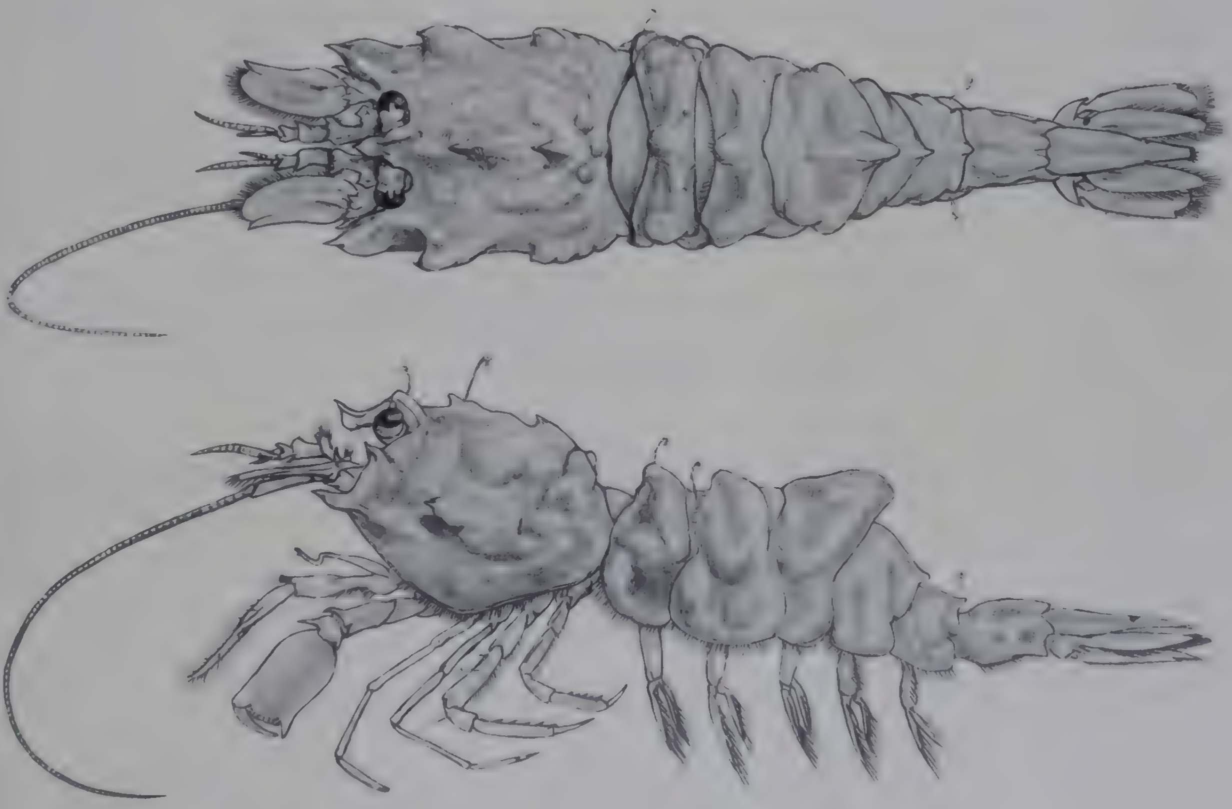
Body stout, depressed. Shell thick, surface knobby. Carapace with two or three median dorsal spines. Fourth and fifth pereiopods much stouter than second and third, setiferous. Pleura of abdominal somites without ventral spines. Outer margin of antennal scale concave. Endopods of pleopods somewhat shorter than exopods. Second pleopod of male with endopod longer than appendix masculina.

Although Zarenkov (298) did not explain the derivation of the generic name, there seems little doubt that he had in mind the Greek root *rhino*, meaning nose, a reference to the type of rostrum found on the two species of the genus, *R. sharpi* (Ortman, 1895) and *R. alata*. Separation of these two species from the genus *Sclerocrangon* appears valid. Placing them in *Sclerocrangon* originally was based on the possession of stout, depressed bodies, and rough sculptured shells. Surfaces of the shells, however, differ from those of a typical species of *Sclerocrangon*, such as *S. boreas*. Vinogradov (266) perhaps was making a point when he proposed the common name "borodavchatyi (warty) shrims" for *R. alata*, and the present author describes the shell surface as knobby. More important, species now in *Rhynocrangon* differ from species of *Sclerocrangon* in the following respects: size and shape of appendix musculina, lack of ventral spines on abdominal pleura, and outer margin of antennal scale concave. For more information on the appendix masculina, characteristic of each genus, and the morphology of *R. sharpi*, the reader is referred to the respective works by Zarenkov (298) and Rathbun (219).

The two small species are restricted in distribution to the continental shelf and upper slope zones in the North Pacific Ocean, including the Bering Sea. One species occurs along the British Columbia coast.

SADDLE-BACK SHRIMP

Rhynocrangon alata (Rathbun, 1902)



Description Body stout, depressed. Shell thick, surface rough, knobby, pubescent overall, pitted. Rostrum short, about 0.5 carapace length, median sulcus, broad base tapering and descending for most of length, then deflected as obliquely erect, acute tip. Carapace spines and carinae: 2 moderate, widely spaced, dorsal spines arising from median carina; antennal moderate, with short supporting carina; branchiostegal very strong, stout, twisted and deflected to or beyond basicerite of antenna, with supporting carina, extending obliquely into midbranchial region; hepatic moderate, recurved, arising from thick, laterally expanded carina; pterygostomian weak; large tubercle in lower cardiac region adjacent to posterior margin; lateral margin of rostrum extending ventrally from base along orbit as thickened marginal ridge; several amorphous ridges and knobs in gastric and cardiac regions, also in lower branchial region. Eye small, directed laterally, cornea well developed, tubercle acute. Antennule: peduncle moderately long, third segment about half length of second, latter with dorsal distal tubercle, third with blunt distal spine, first with prominent setose tubercle; stylocerite short, broad lamella, tip acute; inner flagellum shorter than outer, latter extending beyond antennal scale. Antenna: scale short, moderately wide, outer margin concave, spine extending to tip of lamella; basicerite, lower strong lateral spine, 2 dorsal lobes; peduncle long; flagellum shorter than body. Third maxilliped: long, moderately stout, setiferous; proximal segment with distal lamina; distal segment flattened; exopod long, with lash. Pereiopods: I about as long as third maxilliped, stout; ischium and merus stouter distally; latter, strong curved upper distal spine; carpus, strong distal spine, wide recess under surface for propodus; propodus stout, about 2.0 average width, fixed finger strong; dactylus, when flexed, transverse; II longer than I, slender; chelate; III longer than II, as slender; dactylus about 0.28 propodus length, tip acute; IV shorter than III, stout, setiferous, propodus, about 6 spinules; dactylus slender, about 0.6 propodus length, tip acute; V shorter than IV, less stout; propodus, 6 or 7 spinules; dactylus slender, about 0.5 propodus length, tip acute. Abdomen: first and second somites with large median dorsal tubercles, directed anteriorly, also prominent transverse ridges; on third, high median carina, with oblique posterior projection; fourth and fifth each with median dorsal carina, projected posteriorly as blunt spine; anterior dorsal margins of first and second broadly concave, that of third with slight anterior projection; on lateral surfaces of first to sixth somites, smoothly rounded, irregular protuberances; sixth shorter than telson, with 2 wide, smoothly rounded dorsal carinae, each lateral margin tapers posteriorly, with moderate posteroventral spine; telson moderately wide, tapers to rounded tip, median dorsal sulcus, 2 pairs minute dorsolateral spines; inner uropod longer and narrower than outer, former exceeding telson, outer margin of outer uropod with movable spine.

Remarks The stalked processes, shown in the illustration above on the carapace, abdomen, and pereiopod IV, are not attached organisms but appear to be plumose setae arising from the shell. Also found on other specimens examined.

Color Unavailable.

Distinctions Distinguished by stout, compressed, knobby body; saddlelike appearance of adjoining second and third abdominal somites in lateral view; short, broad chela of pereiopod I; concave outer margin of antennal scale.

Maximum lengths Males: carapace 11.1 mm, total 44 mm; females: carapace 10.6 mm, total 45 mm.

Range Akutan Island, Bering Sea to Puget Sound (219); and to Peter the Great Bay (266); 11–167 m (219).

First known reference to the presence of the species in British Columbia waters was by Taylor (258), who stated that it was not common in Departure Bay and neighboring waters.

Biology and economics Only 3 locally collected specimens were available to the author. One of these, a female 6.3 mm carapace length, was dredged near Saturna Island, on a rocky bottom, at 73 m (Cowan collection). Maximum lengths listed above are from specimens in the collection of the Auke Bay Fisheries Laboratory (AB 62-183). Rathbun (219) lists an ovigerous female, 25.7 mm total length, from an unspecified locality.

Genus *Crangon* Fabricius, 1798

Rostrum relatively short, more or less depressed, with or without median sulcus. Eyes present, free. Spines on carapace: median, one or two, or absent; suborbital, antennal, branchiostegal, pterygostomian, all present. Inner or ventral spine on merus of first pereiopod, present or absent. Fourth and fifth pereiopods a little stouter than second and third, dactyli of former slightly flattened. Ventral spines on fourth and fifth pleura of abdominal somites present or absent. Arthrobranchia on third maxilliped present but reduced, or absent. Endopod of second pleopod of male longer than appendix masculina. Shell surface generally smooth.

The generic name *Crago* Lamarck, 1801 is superseded by *Crangon* Fabricius, 1798 (131).

In accord with Zarenkov's revision (298), the genus *Crangon* is taken, in the present usage, to include all shrimps assigned to the genus by Rathbun (219), with the exception of those species having the gastric region depressed below the rest of the carapace, and/or submedian spines. A separation into two subgenera, *Crangon* s.s. and *Neocrangon,* was proposed by Zarenkov (298). His diagnosis of the former included the characters, presence of an arthrobranch gill on the third maxilliped and one median carapace spine; and of the latter, absence of arthrobranch gill and presence of one median spine. Examination of British Columbia material available to the present author revealed that the species, *alaskensis, stylirostris,* and *alba,* have the subgeneric characters (except *stylirostris,* lacking a median spine) specified for *Crangon.* In the case of *Neocrangon,* however, there is disagreement with Zarenkov's diagnosis. Local species, *communis* and *abyssorum,* lack an arthrobranch gill, but have two median spines, though the anterior one is weaker; species with one median spine, *nigricauda, dalli, franciscorum franciscorum,* and *f. angustimana,* have an arthrobranch gill on the third maxilliped. The present author is of the opinion, therefore, that separation of *Crangon* into two subgenera, as proposed by Zarenkov, is invalid.

Rathbun established two forms or varieties (217), *Crangon franciscorum angustima* and *C. alaskensis elongata.* The former category has been retained in the present work, the latter has been dropped, at least for populations in British Columbia waters.

There is no published local record of *C. resima* Rathbun, 1902. As it is known from the Washington coast (159) and reasonably may be expected to appear eventually in Canadian waters, the species is included here in the key. As the present writer has not examined specimens of *C. resima,* some diagnostic characters were taken from Rathbun's key (219).

The number of species in the genus may be set at 15–20 (179, 298), depending on the status of lesser known species. Most occur on the continental shelf in the North Pacific and Atlantic oceans. As bottom dwellers, these shrimps probably form an important part of the food of demersal fishes and invertebrates. Some known predators are copper rockfish, *Sebastes caurinus* Richardson, 1845, on *Crangon nigromaculata* Lockington, 1877 (214); 19 fishes, including whiting, *Gadus merlangus* Linnaeus, 1785, on *C. crangon* Linnaeus, 1785 (262); Dungeness crab (Dana, 1852) on *Crangon* sp. Following weaning, harbor seal pups (*Phoca vitulina* Linnaeus, 1758) feed mainly on species of *Crangon* before changing to a fish diet in all areas recorded in the Pacific and Atlantic (36). Several members of the genus are fished commercially, but the only one of major importance is the common shrimp. *C. crangon,* in European waters (135). Its biology and that of another species, *C. allmani,* are known (6, 169).

The generic name was derived directly from the Greek word "krangon," for shrimp. The author took the obvious course by naming the nine species described in this Bulletin "crangons." Carapace spines are shown on the drawing of a hypothetical crangon (Fig. 14).

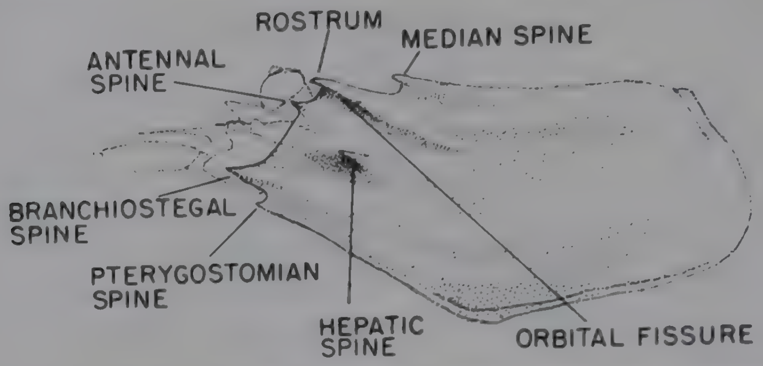

ROSTRUM
MEDIAN SPINE
ANTENNAL SPINE
BRANCHIOSTEGAL SPINE
PTERYGOSTOMIAN SPINE
HEPATIC SPINE
ORBITAL FISSURE

FIG. 14. Hypothetical carapace of a crangon, showing terms used in species accounts.

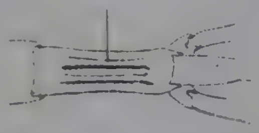
Key to species of genus *Crangon*

1 Carapace with 1 or 2 median dorsal spines 2

Carapace lacks median dorsal spine .... Smooth crangon, *C. stylirostris* (p. 98)

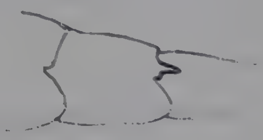
2 Carapace with 1 median dorsal spine 3

Carapace with 2 median dorsal spines 8



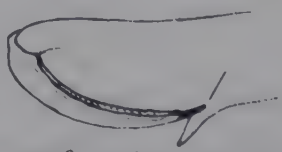
3 Dorsal surface of sixth somite with 2 prominent carinae .... Ridged crangon, *C. dalli* (p. 99)

Dorsal surface of sixth somite smooth, or with faint median sulcus 4

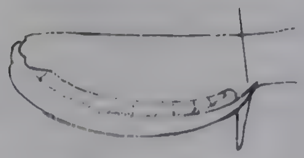


4 Upper posterolateral margin of fifth somite with strong spine 5

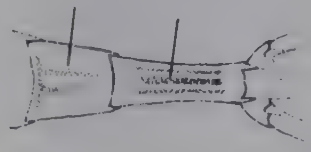
Upper posterolateral margin of fifth somite without spine 6



5 Antennal scale longer than chela of first pereiopod; tip of dactylus of latter not crossing the under basal part of fixed finger .... Bay crangon, *C. franciscorum franciscorum* (p. 101)

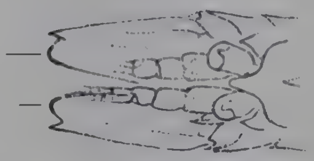


Antennal scale varying from longer to shorter than chela of first pereiopod; tip of dactylus of latter crossing under basal part of fixed finger .... Long-clawed crangon, *C. franciscorum angustimana* (p. 103)

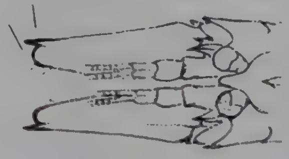


6 Dorsal surface of fifth somite with faint carina; dorsal surface of sixth with faint median sulcus 7

Dorsal surfaces of fifth and sixth somites smooth .... Stout crangon, *C. alba* (p. 104)



7 Antennal scale shorter than telson; tip of lamina of antennal scale longer mesially, reaching or exceeding tip of spine .... Sand crangon, *C. nigricauda* (p. 106)



Antennal scale as long as, sometimes slightly shorter than, telson; spine of antennal scale exceeding rounded tip of lamina .... Northern crangon, *C. alaskensis* (p. 108)

8 Rostrum tip rounded; pubescence on carapace, and in sulci on abdomen .... Common two-spined crangon, *C. communis* (p. 110)

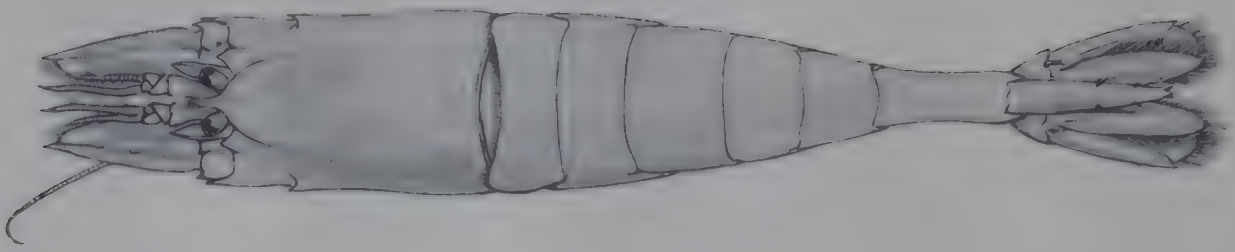
Rostrum tip acute; pubescence lacking 9

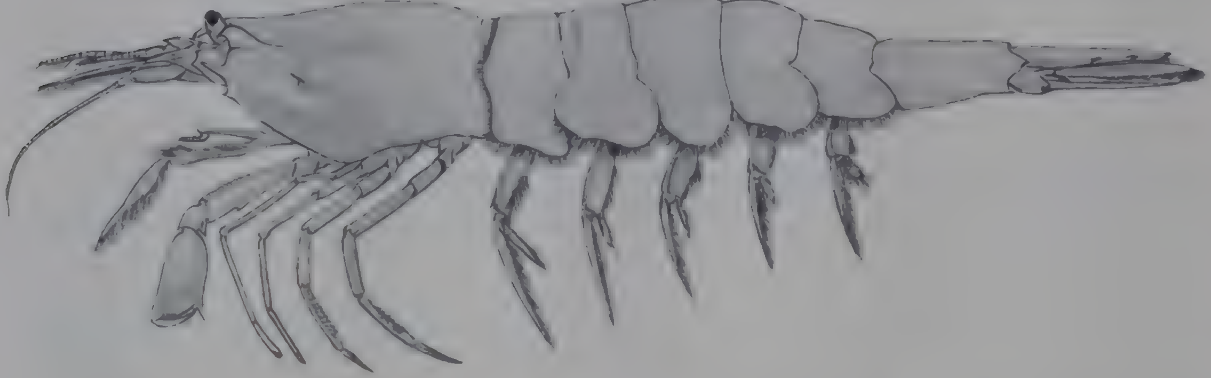
9 Eyes very large, contiguous mesially; shell very thin .... Abyssal crangon, *C. abyssorum* (p. 112)

Eyes moderate size, not contiguous; shell thin .... [*C. resima* Rathbun, 1902] (p. 95)

SMOOTH CRANGON

Crangon stylirostris Holmes, 1900





Description Body moderately stout, depressed. Shell thin, surface smooth. Rostrum short, about 0.15 carapace length, narrow, median sulcus, descending, tip acute. Carapace spines: lacks median; antennal strong; hepatic strong, with oblique supporting carina; branchiostegal strong, pterygostomian moderate; lateral margin of rostrum extending posteriorly as ridge to posterior third of carapace. Band around ventral margin of carapace, widening to lobe adjacent to base of pereiopod II. Eye small, cornea poorly developed, tubercle weak, stalk short. Antennule: peduncle moderately long, third segment subequal to second, stylocerite moderately long, knifelike; inner flagellum exceeds antennal scale, longer than outer. Antenna: scale as long as or longer than telson, spine exceeding lamella, latter with oblique inner margin; basicerite, 2 weak lateral spines; peduncle moderately long; flagellum shorter than body. Third maxilliped: short, moderately stout, setiferous; antepenulimate segment broad; penultimate and distal segments flattened; exopod moderately long, with lash. Pereiopods: I longer than third maxilliped, very stout; merus, inner spine in distal half; carpus, 2 spines; propodus widens distally, 2.0–2.2 propodus width, fixed finger strong, slender; dactylus, when flexed, obliquely transverse; II longer than I, slender, chelate; III about as long as II, as slender; dactylus slender; about 0.25 propodus length; IV longer than III, stouter; propodus, outer margin setiferous; dactylus slender, slightly flattened, about 0.55 propodus length; V about as long as IV, as stout; propodus, outer margin setiferous; dactylus slender, slightly flattened, about 0.6 propodus length. Abdomen: ventral margins of pleura of first, second, and fourth somites concave; sixth with moderate posteroventral spine, slight ventral sulcus; telson narrow, tapering to acute tip, 2 pairs lateral spines; inner uropod narrower and slightly longer than outer, both extend beyond end of telson.

Color Unavailable.

Distinctions Identified by absence of median spine on carapace; short, stout chela of pereiopod I; setiferous propodi of pereiopods IV and V.

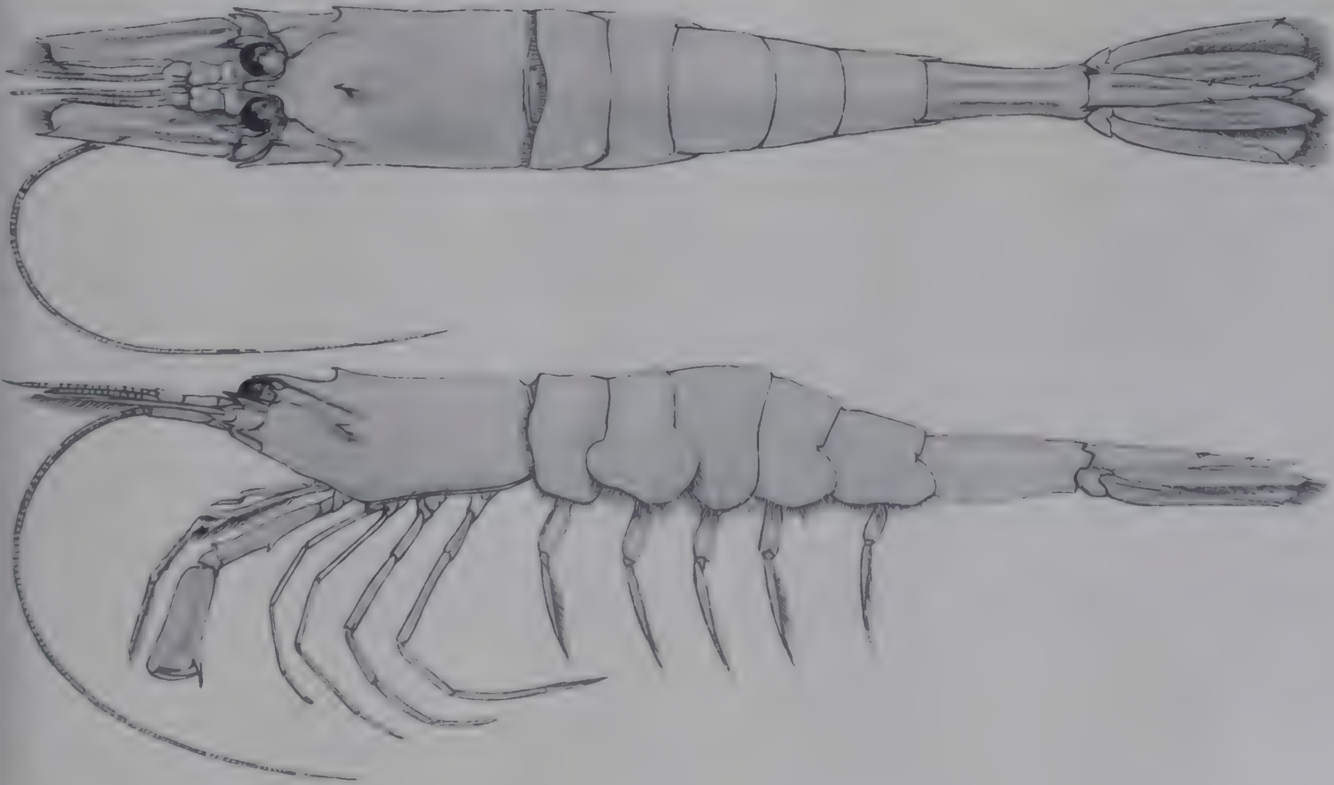
Maximum lengths Males: carapace 9.9 mm, total 43 mm; females: carapace 14.5 mm, total 61 mm.

Range Chirikof Island, AK, to Santa Cruz, CA (219); intertidal to 80 m (250, 43). First recorded from British Columbia waters by Taylor (250), who collected some specimens east of Rose Spit in Hecate Strait, on an unspecified date.

Biology and economics *C. stylirostris* occurs fairly commonly on exposed, sandy beaches on the west coast of Vancouver Island, and on the Queen Charlotte Islands, also in the shallow sublittoral (to 13 m) adjacent to these beaches. Apparently it is well adapted to burying itself in the sand at the surf line and higher in the sand by having flattened segments of the third maxilliped; a broad chela of pereiopod I; the slightly flattened dactyli of pereiopods IV and V; the flattened protopodites of all pleopods. Orientation of the eyes and the setiferous propodi of pereiopods IV and V probably are of value to the shrimp in its special habitat. Ovigerous females, 10.0–14.5 mm carapace length, were caught in Hecate Strait, June 22, 1952. This shrimp is infested by the branchial parasite, *Argeia pugettensis* (89). In California it was reported as common in the surf zone of semiprotected sandy beaches, and in the sublittoral on sandy-rocky bottoms (68). The species occurred mainly on a more or less hard, predominantly sandy bottom in San Francisco Bay, at temperatures 8.7–16.0°C, and salinities 17.4–34.1‰ (232). Two ovigerous females, both 8.0 mm carapace length, were caught by trawling near Juneau, southeastern Alaska, at 77–80 m, June 15, 1961 (250, 43).

RIDGED CRANGON

Crangon dalli Rathbun, 1902



Description Body moderately stout, depressed. Shell thin, surface smooth. Rostrum short, about 0.2 carapace length, median sulcus, outer margins more or less parallel, slightly descending, tip rounded. Carapace spines: 1 median in anterior third of carapace; antennal moderate; hepatic moderate, with short oblique supporting carina, slightly anterior to median; branchiostegal strong, with supporting carina; pterygostomian moderate; lateral margin of rostrum extending posteriorly over orbital fissure as ridge above and beyond hepatic spine; carina extending from antennal spine posteriorly joining hepatic spine. Band around ventral margin of carapace widening to lobe adjacent to base of pereiopod II. Eye moderately large, cornea well developed, weak tubercle. Antennule: peduncle moderately long, third segment subequal to second, first segment with blunt inner dorsal distal spine; stylocerite moderate; inner flagellum exceeding antennal scale, longer than outer. Antenna: scale shorter than telson, spine exceeding lamella; basicerite, 2 moderate lateral spines; peduncle moderately long; flagellum shorter than body. Third maxilliped: moderately long, slender, setiferous; exopod long, with lash. Pereiopods: I about as long as third maxilliped, stout; merus, inner spine at middle, bifurcated distal lobe; carpus, 2 distal spines; propodus widens distally, 2.5–2.7 average width, fixed finger moderate, slender; dactylus, when flexed, obliquely transverse; II shorter than I, slender; chelate; III longer than II, similarly slender; dactylus slender, about 0.4 propodus length; IV longer than III, stouter; dactylus slender, about 0.85 propodus length; V longer than IV, as stout; dactylus slender, about 0.8 propodus length. Abdomen: ventral margins of pleura of first and second somites straight and slightly concave, respectively; second with faint transverse sulcus; ventral margin of pleuron of fifth slightly concave; sixth with 2 prominent dorsal carinae, shorter than length of somite, slight ventral sulcus; telson narrow, tapering to acute tip, with dorsal median sulcus, 2 pairs dorsolateral spines; inner uropod longer than outer, both extend beyond telson.

Color Unavailable.

Distinctions Distinguished from other crangons with a single median spine on carapace, by 2 prominent dorsal carinae on sixth abdominal somite, slightly concave margin of pleuron of fifth abdominal somite, and blunt inner dorsal distal spine on first antennular peduncle.

Maximum lengths Males: carapace 11.0 mm, total 50 mm; females: carapace 18.3 mm, total 80 mm.

Range Chukchi Sea (266); Bering Sea to Puget Sound (219); Okhotsk Sea; Sea of Japan, to Peter the Great Bay (266); east coast of Japan (265); 3–630 m (266).

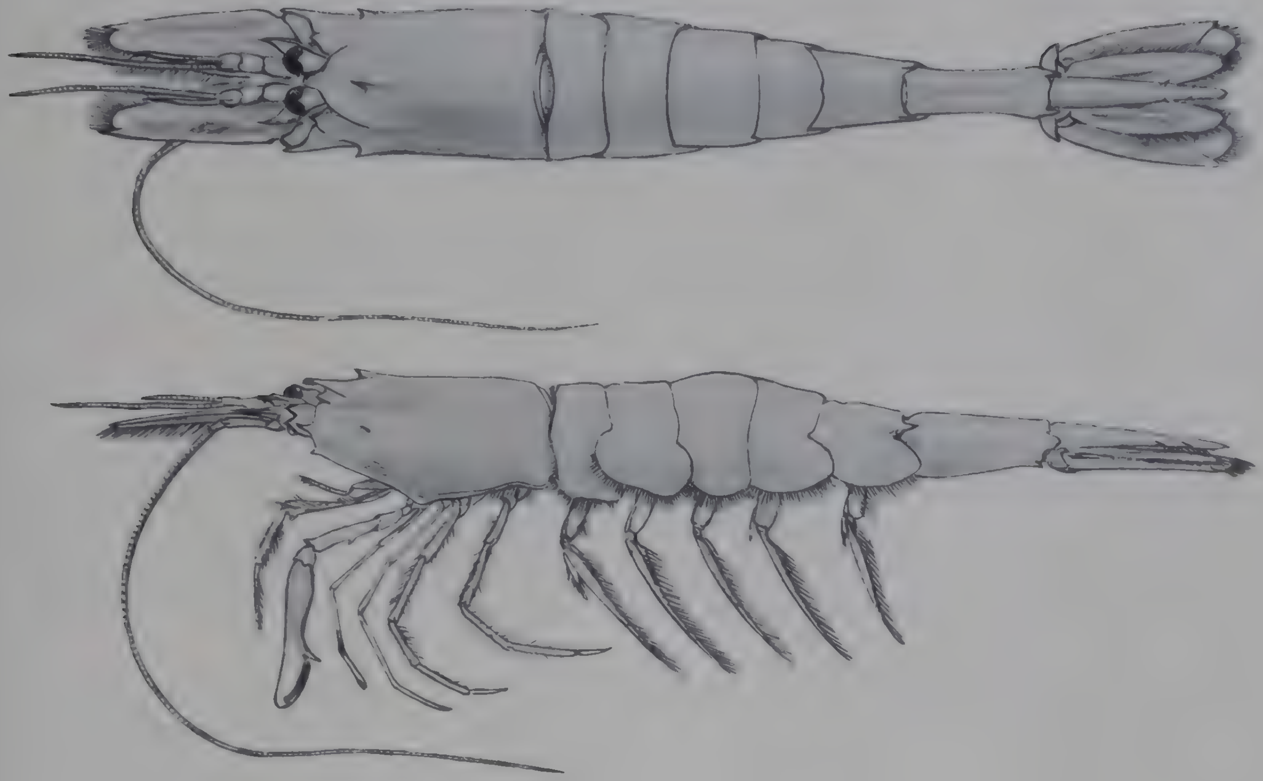
The first known record of the species in British Columbia waters was the capture of 2 specimens in Grandby Bay, at 88–90 m, Sept. 25, 1954.

Biology and economics There are relatively few local records of *C. dalli.* Large catches of the species were made at *Albatross* stations in the Bering Sea and Bellingham Bay (217). In the eastern Bering Sea it occurred at 38–110 m, on bottom sediments varying from fine mud to coarse sand, and at spring and summer temperatures -1.4 to 6.4°C (187). All 5 larval stages and postlarvae of *C. dalli* were found during June and July surveys along the west coast of Kamtschatka (176). A parasite is the branchial isopod, *Argeia pugettensis* (225). Two predators are Pacific cod *(Gadus macrocephalus)* (217), and sand sole (189).

The number of eggs was estimated as 4290, and egg measurements were 0.5 × 0.45 mm (298). Three specimens were caught by trawling in Prince William Sound at 46–70 m (250, 43).

BAY CRANGON

Crangon franciscorum franciscorum Stimpson, 1856



Description Body moderately stout, depressed. Shell thin, surface smooth. Rostrum short, about 0.15 carapace length, with median sulcus, ascending, tip broadly rounded. Carapace spines: 1 median in anterior fifth of carapace; antennal moderate; hepatic moderate, in line with median; branchiostegal moderate; pterygostomian moderate; orbital margin extending posteriorly over orbital fissure as ridge beyond center of carapace. Band around ventral margin of carapace, widening to lobe adjacent to base of pereiopod II. Eye moderately large, cornea well developed, tubercle weak. Antennule: peduncle short, third segment subequal to second, blunt inner, dorsal, distal spine on first segment; stylocerite moderately long, inner flagellum exceeding antennal scale considerably, outer third to half as long. Antenna: scale about as long as telson, spine exceeding evenly rounded tip of lamella; basicerite, upper lateral lobe, moderate lower spine; peduncle short; flagellum as long as or longer than body. Third maxilliped: moderately long, slender, setiferous; exopod short, with lash. Pereiopods: I longer than third maxilliped, stout; merus, inner spine in proximal half, outer distal lobe; propodus narrow, long, 4.0–5.5 average width, longer in males, fixed finger long, slender; dactylus, when flexed, almost longitudinal, and not crossing the under basal part of fixed finger; II shorter than I, slender; chelate; III longer than II, slender; dactylus slender, about 0.25 propodus length; IV longer than III, a little stouter, setiferous; dactylus about 0.7 propodus length; V longer than IV, as stout, setiferous; dactylus slender, about 0.6 propodus length. Abdomen: ventral margins of pleura of first and second somites straight or slightly concave; fifth with stout posterolateral spine above articular knob, dorsal transverse sulcus; sixth slender, shorter than telson, moderate posteroventral spine with small lobe above, ventral sulcus; telson narrow, tapering to acute tip, 2 pairs lateral spines in distal half; outer uropod equal to or slightly longer than inner, both reach or exceed telson slightly.

Remarks As stated earlier, the category *C. franciscorum angustimana* proposed by Rathbun (217) has been retained, and reasons are presented later (p. 104), where it is also designated as a subspecies. The typical subspecies, *C. f. franciscorum,* therefore, is considered as the appropriate category for intertidal and shallow sublittoral populations ranging from the Gulf of Alaska to southern California. Although the present author has not examined material of *C. f. franciscorum* from other Pacific coastal areas, the morphology of local specimens agrees with descriptions published earlier (128, 219). This subspecies appears to inhabit a different ecological zone than *C. f. angustimana,* the former living successfully in shallow bays and estuaries within a wide range of temperatures and salinities.

Color Dark and light yellowish gray mottled; eyes salmon colored in life (253).

Distinctions Distinguished by stout spine on upper posterolateral margin of fifth abdominal somite; antennal scale apparently invariably longer than chela of pereiopod I; same chela with tip of dactylus not crossing the under basal part of fixed finger; and dactylus of pereiopod III, about 0.25 length of its propodus.

Maximum lengths Males: carapace 9.7 mm, total 49 mm; females: carapace 14.6 mm, total 68 mm.

Range Resurrection Bay, AK (250, 43), to San Diego, CA (219), intertidal (232) to 91 m (207). The reported occurrence off Oregon at 1426 m (185) may have been an error.

Early records of *C. f. franciscorum* are unknown. The author identified specimens from catches by a commercial shrimp trawler fishing near Second Narrows at about 36 m, July 13, 1948.

Biology and economics This subspecies appears to be euryhaline over most of its range. It was collected at 10 intertidal localities (3 near river mouths) in southeastern Alaska and Prince William Sound at salinities 2.2–28.3‰ (250, 43). In San Francisco Bay, specimens were taken at localities where bottom salinities were 7.79–33.27‰, and at estuarine stations where indicated salinities were "much below any recorded during the survey" (232). Also, the shrimps occurred in Yaquina Bay, OR, at salinities 0.2–34.4‰, and, except for ovigerous females, showed preference for lower salinities, particularly immature individuals (161). The latter were more abundant further into the estuary than larger individuals. Observations in this Oregon bay showed a temperature range 5.2–21.3°C for occurrence of young and adult shrimps and 6.8–19.2°C for ovigerous females. There is a lack of information on distribution and abundance of the bay shrimp in local estuaries. In Departure Bay it is less abundant than *C. alaskensis* and *C. nigricauda.*

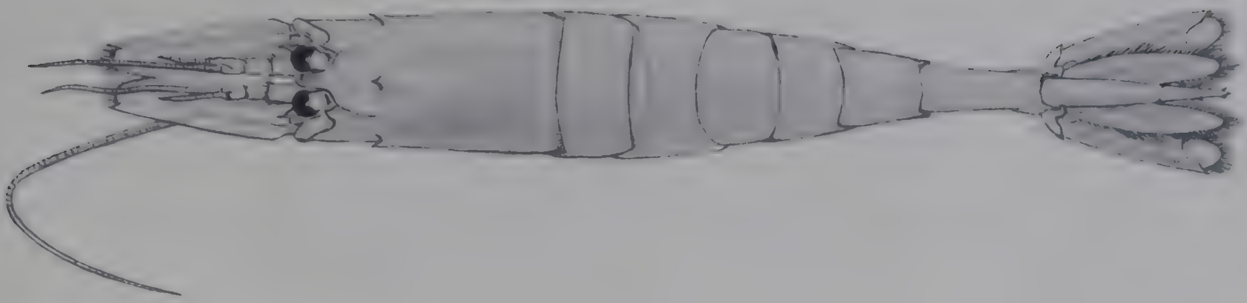
In Yaquina Bay ovigerous females are present from December to the middle of August; there is bimodal spawning, with earlier spawning of larger individuals. Females, 47.8–67.4 mm total length, were observed carrying 1923–4764 eggs. Most females mature at about 48 mm total length, and males at 34 mm (161). Minimum size of maturity of females was 53 mm in San Francisco Bay (139). Two groups with separate growth rates arise from bimodal spawning in Yaquina Bay: larvae of 1 group hatch in early spring, are juveniles by May–July, and mature in December. The other group hatches during the latter part of summer, are juveniles by December, and are mature the following summer. Males live for 1 yr, reaching 50–52 mm maximum length after spawning once; females spawn twice, and are about 60 mm after 1½ yr of life (161).

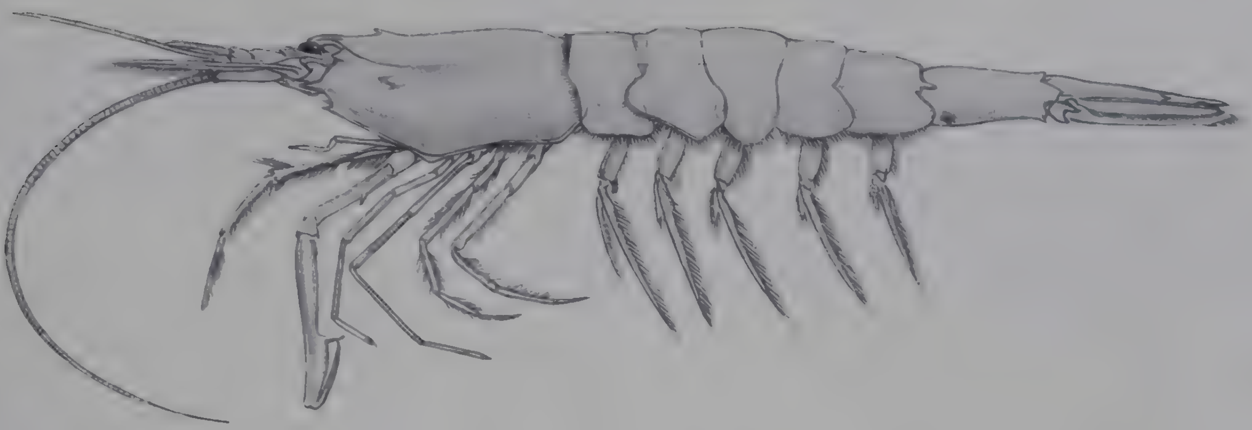
The branchial isopod, *Argeia pugettensis,* is parasitic (225, 100). As no infested female in Yaquina Bay was ovigerous during normal spawning periods, normal reproduction appeared inhibited (161).

The shrimp fishery in San Francisco Bay, that commenced about 1869 and remained important for the better part of a century, exploited this subspecies together with *C. nigricauda* and a minor species, *C. nigromaculata.* Bottom trawls, fyke net, and seines were employed (139). Present day operations are of minor importance (171).

LONG-CLAWED CRANGON

Crangon franciscorum angustimana Rathbun, 1902





Description Body slender, depressed. Shell thin, surface smooth. Rostrum short, about 0.15 carapace length, median sulcus, slightly descending, tip rounded. Carapace spines: median, in anterior third of carapace; antennal moderate; hepatic moderate, in line with median; branchiostegal strong, reaching or exceeding distal end of basicerite of antenna; pterygostomian moderate to strong; lateral margin of carapace extending posteriorly over orbital fissure as ridge beyond center of carapace. Band around ventral margin of carapace, widening to lobe between bases of pereiopods I and II. Eye moderately large, cornea well developed and reaching to end of rostrum, tubercle weak. Antennule: peduncle moderately long, third segment about equal to second, first segment with inner, dorsal, distal spine; stylocerite short; inner flagellum exceeding antennal scale considerably, outer less than half as long. Antenna: scale about as long as telson, spine exceeding evenly rounded tip of lamella; basicerite, 2 lateral spines; peduncle moderately long; flagellum as long as or longer than body. Third maxilliped: moderately long, slender; exopod long, with lash. Pereiopods: I longer than third maxilliped, moderately stout; merus, inner spine in proximal half; propodus slender, very long, 6.0–8.0 average width, fixed finger long, slender, directed almost transversely; dactylus, when flexed, almost longitudinal, crossing under basal part of fixed finger; II shorter than I, slender; chelate; III longer than II, slender; dactylus slender, about 0.15 propodus length; IV shorter than III, stouter, setiferous; dactylus slender, about 0.85 length of propodus; V longer than IV, as stout, setiferous; dactylus slender, about 0.6 propodus length. Abdomen: ventral margins of pleura of first and second somites straight or slightly concave; fifth with stout posterolateral spine above articular knob, faint dorsal transverse suture; sixth slender, shorter than telson, dorsal surface flattened in posterior third, with moderate posteroventral spine and small lobe above, ventral sulcus; telson narrow, tapering to acute point, 2 pairs lateral spines, in distal half of telson; outer uropod slightly longer than inner, former reaches or exceeds tip of telson.

Remarks Rathbun created the category *C. f. angustimana* in 1902 (217), for individuals differing from those in the typical species by the shape of the chela of pereiopod I. In 1904 (219), she stated that representatives of the form, *C. f. angustimana,* were in deeper water. As far as the present author is aware, there is no available evidence that negates her action; rather, present information appears supportive and, to some extent, complementary. There are about 5 additional local records (18–183 m), and other morphological differences: position of flexed dactylus of pereiopod I, with respect to fixed finger; and somewhat shorter dactylus of pereiopod III, both described above. Individuals with these characters inhabit an ecological zone, in deeper water with a narrower range of temperatures and salinities, apparently different from that frequented by members of the typical species. The author accordingly is of the opinion that separation of *C. franciscorum* into 2 subspecies is valid and appropriate, at least for British Columbia populations.

Color Unavailable.

Distinctions *C. f. angustimana* is distinguished by stout spine on upper posterolateral margin of fifth abdominal somite; long slender chela of pereiopod I, 6.0–8.0 times average width, varying from slightly shorter to somewhat longer than antennal scale, but with tip of dactylus crossing under basal part of fixed finger; relatively short dactylus of pereiopod III, about 0.15 length of propodus.

Maximum lengths Males: carapace 11.5 mm, total 53 mm; females: carapace 21.6 mm, total 84 mm.

Range Kachemak Bay, AK, to Tillamook Rock, OR (219); 18–183 m. Northern limit above, based on specimens kindly provided by E. Haynes. Minimum depth, that of trawl tow in McIntyre Bay, May 19, 1965; maximum depth, from trawl tow in Strait of Georgia, Dec. 5, 1963.

The first known capture in British Columbia waters was by the *Albatross,* west of Jordan River at 97 m, Sept. 2, 1891 (station 3460) (219). *Albatross* station 2863 (219) was actually in United States waters (285).

Biology and economics Masset Inlet is the only area where this subspecies has been caught in any numbers. Ovigerous females, 12.9–21.6 mm carapace length, occurred in May, August, and September. This shrimp is parasitized by the branchial isopod *Argeia pugettensis* (225).

STOUT CRANGON

Crangon alba Holmes, 1900

Description Body, stout, depressed. Shell thin, surface smooth. Rostrum short, slightly descending, median sulcus, tip rounded. Carapace spines: 1 median, in anterior third of carapace; antennal moderate; hepatic, moderate with short oblique supporting carina; branchiostegal strong; pterygostomian weak; lateral margin of rostrum extending posteriorly over orbital fissure to about middle of carapace. Eye moderately large, cornea well developed, tubercle weak. Antennule: peduncle moderately long, third segment about as long as second; stylocerite short; outer flagellum shorter than antennal scale, length of inner unavailable. Antenna: scale about as long as telson, inner margin very oblique, spine extending considerably beyond lamella (Fig. 15A); basicerite, 2 strong lateral spines; peduncle moderately long, length of flagellum unavailable. Third maxilliped: moderately long, reaching tip of antennal scale, segments flattened, particularly antepenultimate; exopod moderately long, with lash (Fig. 15B). Pereiopods: I shorter than third maxilliped, stout; inner spine in proximal half; propodus widens distally, 2.2–2.5 average width, fixed finger strong; dactylus, when flexed, obliquely transverse (Fig. 15C); II longer than I, slender, chelate; III shorter than II, as slender; dactylus slender, about 0.4 propodus length; IV longer than III, slightly stouter; dactylus slender, about 0.5 propodus length; V slightly longer than IV, as stout; dactylus, about 0.5 propodus length. Abdomen: ventral margins of pleura of first to third somites mainly straight or slightly concave; dorsal surfaces of all somites smooth; sixth shorter than telson, deep, ventral sulcus lacking, posteroventral spine weak; telson, 2 lateral spines; inner uropod slightly longer than outer, both exceed tip of telson.

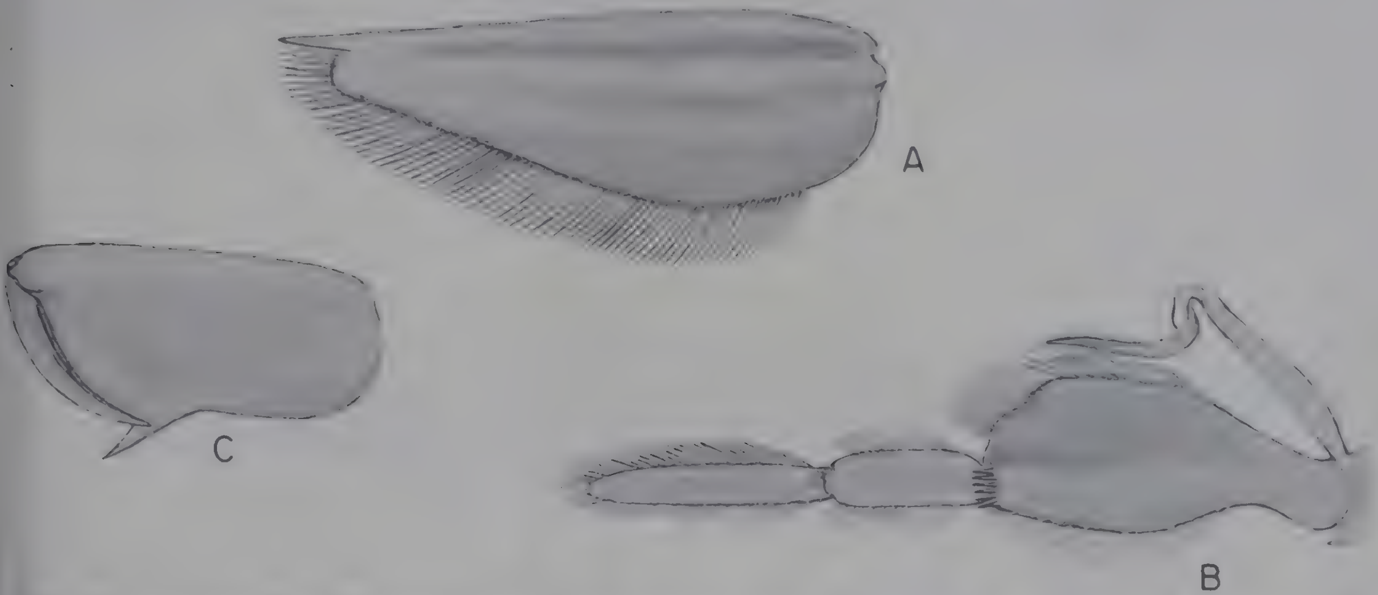


FIG. 15. *Crangon alba.* (A) dorsal view of right antennal scale, (B) ventral view of left third maxilliped, (C) lateral view of chela of left pereiopod I.

Color Nearly white (128). White dotted with black (232).

Distinctions Noteworthy for stout body; greatly flattened antepenultimate segment of third maxilliped; short, stout chela of pereiopod I; lack of dorsal median carinae on abdominal somites, and ventral sulcus on sixth somite.

Maximum lengths Males: unavailable; females: carapace 9.3 mm, total 44 mm.

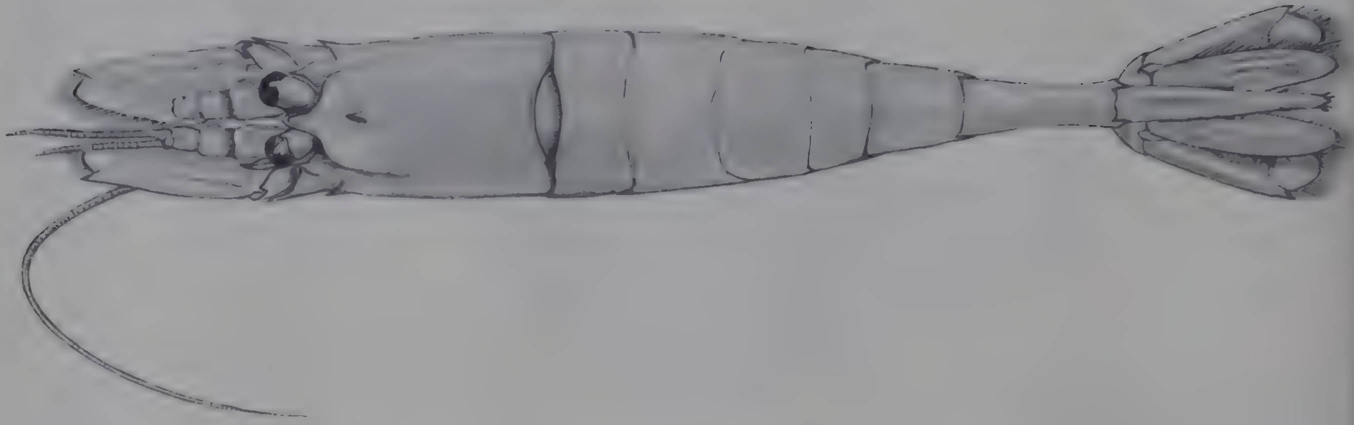
Range Queen Charlotte Strait, northeast Vancouver Island to south of San Diego Bay; 22–86 m (219).

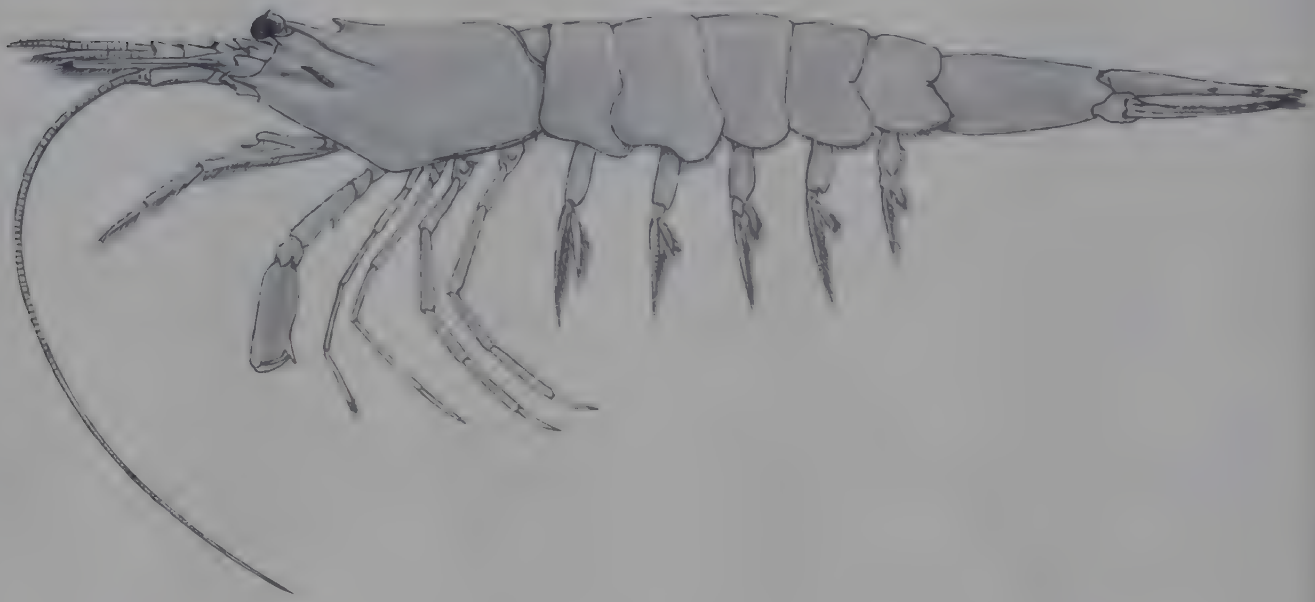
First collected on the British Columbia coast northwest of Barkley Sound at 44 m, Sept. 25, 1888, by the *Albatross* (station 2879). More specimens were caught in another haul (station 2880) at the same locality on the same day. A specimen was captured at Hope Island, Queen Charlotte Strait (258). A locality record (225) of the species parasitized by the branchial isopod, *Argeia pugettensis,* was off Nanaimo, in the Strait of Georgia. Any subsequent occurrence of the shrimp is not known.

Biology and economics The type of bottom at the above *Albatross* stations was listed as "rocks" (285). Outside San Francisco Bay the species was dredged by the *Albatross* (station D5790) at 60–64 m, on a bottom described as "very coarse, variegated sand, with a small proportion of fine sand" (232). As a result of modern collecting (290), it has been termed primarily an "island species," presumably referring to a distribution around offshore islands in southern California.

SAND CRANGON

Crangon nigricauda Holmes, 1900





Description: Body moderately stout, depressed. Shell thin, surface smooth. Rostrum short, about 0.16 carapace length, with median sulcus, ascending, tip rounded. Carapace spines: 1 median in anterior third of carapace; antennal moderate; hepatic moderate with short oblique supporting carina, anterior to median; branchiostegal strong, with supporting carina; pterygostomian weak; lateral margin of rostrum extending posteriorly over orbital fissure to almost center of carapace. Band around ventral margin of carapace, widening to lobe adjacent to base of pereiopod I or II. Eye moderately large, cornea well developed, tubercle weak. Antennule: peduncle moderately long, third segment subequal to second; stylocerite short; inner flagellum longer than outer, both extend beyond antennal scale. Antenna: scale shorter than telson, tip of lamella longer mesially, and may or may not exceed spine; basicerite, peduncle moderately long, 2 lateral lobes; flagellum as long as body. Third maxilliped: moderately long, slender; exopod short, with lash. Pereiopods: I about as long as third maxilliped, stout; merus with inner spine; carpus, distal spine; propodus oblong, 2.4–2.8 average width, fixed finger strong; dactylus, when flexed, obliquely transverse; II longer than I, slender; chelate; III longer than II, similarly slender; dactylus slender, about 0.12 propodus length; IV longer than III, stouter; dactylus slender, about 0.7 propodus length; V as long as IV, similarly stout; dactylus slender, about 0.6 propodus length. Abdomen: ventral margins of pleura of first and second somites concave; fifth with blunt dorsal median carina, short transverse sulcus at anterior end; sixth with broad median dorsal carina, and narrow sulcus along midline, ventral sulcus, moderate posteroventral spine; telson narrow, tapering to sharp point, broad shallow sulcus in anterior half, 2 pairs dorsolateral spines; widely spaced; inner uropod longer than outer, and exceeding telson.

Color In California, reported as very dark gray, or blackish, becoming entirely black on tail fan; chelae of pereiopod I tinted with lilac (253).

Distinctions The sand crangon is distinguished by moderately stout body; telson markedly longer than antennal scale; lamina of antennal scale with tip longer mesially, reaching or exceeding spine; outer antennular flagellum distinctly exceeding antennal scale.

Maximum lengths Males: carapace 6.4 mm, total 32 mm; females: carapace 12.5 mm, total 53 mm.

Range Prince William Sound, AK (250, 43), to San Geronimo Island, Baja California (219); intertidal to 57 m (232).

It is quite possible that the species referred to as *Crangon vulgaris* Fabricius in early lists (172, 242) was *C. nigricauda* (258). There is a record by the *Albatross* from Comox, probably from shore collection, May 30 or 31, 1893 (219).

Biology and economics *C. nigricauda* appears about as common as *C. alaskensis* in Departure Bay and other sheltered localities, on predominantly sand bottoms. In San Francisco Bay, there was a tendency for the species to live on a mud bottom but the possibility of a sampling bias due to use of an effective sledge trawl exclusively on mud bottoms was taken into account (232). Generally in California, *C. nigricauda* lives "among eelgrass, rocks and on sand bottoms" (68).

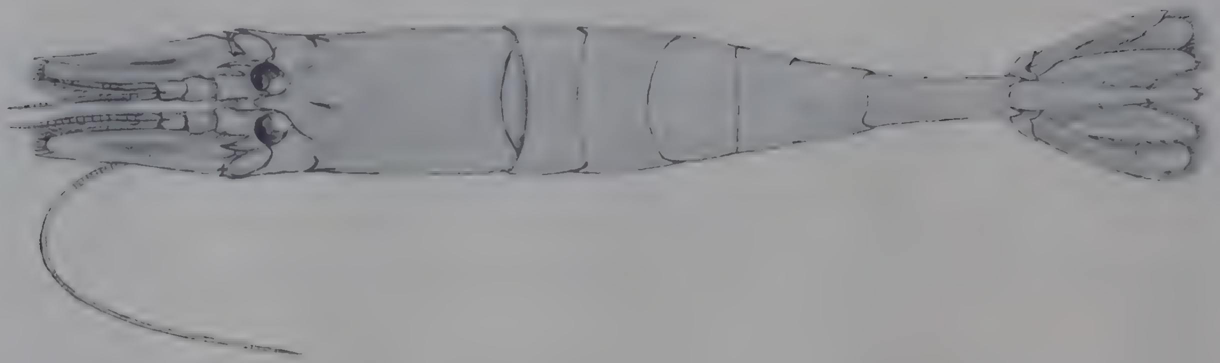
C. nigricauda is less able than *C. f. franciscorum* to tolerate low salinities. In Yaquina Bay, OR., the former was rarely taken in salinities less than 19‰, and ovigerous females of the species frequented water of salinities 25.4‰ and higher, concomitant temperature range for juveniles and adults was 5.3-16.5°C, for ovigerous females mainly 8.0-11.0°C (161). The salinity range in San Francisco Bay was 13.35-32.27‰ (232).

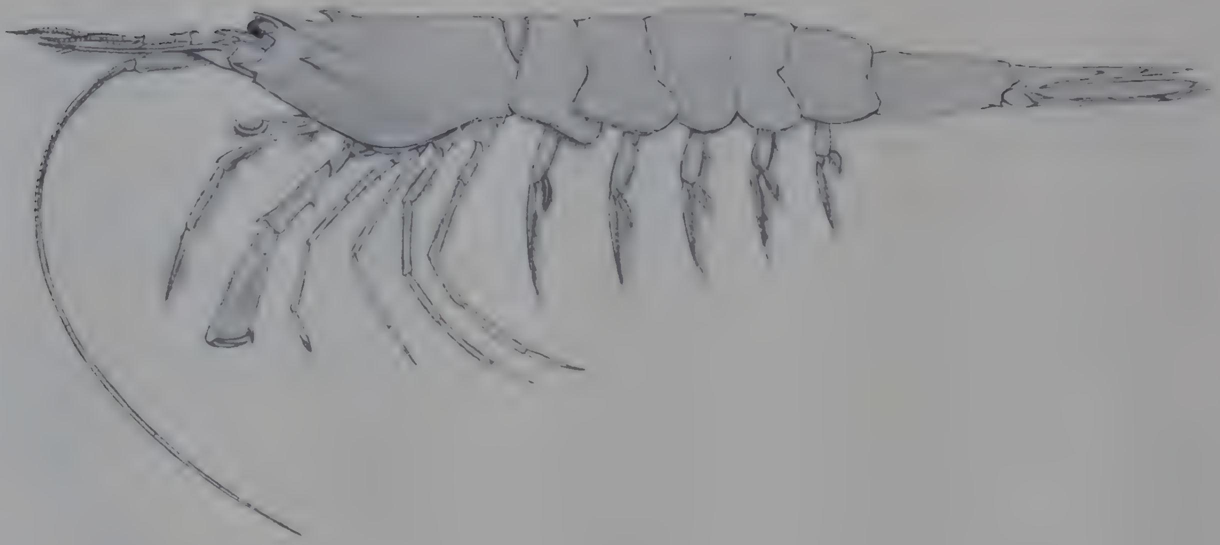
The ovigerous period in Yaquina Bay lasts from December to mid-August, with 2 spawning peaks, the larger individuals releasing larvae prior to April. Observed fecundity for females, 43.2-60.2 mm total length, was 2393-7000 eggs. Females were mature at 36.2-61.4 mm total length, males at 26-28 mm (161). All females 37 mm and longer were mature in San Francisco Bay (139). The 2 groups recruited from bimodal spawning in Yaquina Bay differ in growth rates. The earlier group hatches in late winter or early spring, settles on the bottom by mid-June, and grows steadily to maturity the following winter; the other group hatches during late summer, has settled to the bottom by December, and reaches maturity by the following summer. Males spawn once, and are 40 mm total length or less after 1 yr of life; females live for about 1½ yr, reaching a maximum length of 55 mm, after spawning twice (161). Growth and reproduction of the species in San Francisco Bay was reported (139). This shrimp is parasitized by the branchial isopod, *Argeia pugettensis* (225) (Fig. 3B). Infestation was estimated at 3-5% (226).

Along with *C. f. franciscorum*, and to a lesser extent *C. nigromaculata*, it supported a commercial shrimp fishery in San Francisco Bay that started about 1869, and was important for many years. Fishermen employed seines, bottom trawls, and fyke nets (139). The present fishery is minor (171).

NORTHERN CRANGON

Crangon alaskensis Lockington, 1877





Description Body slender, depressed. Shell thin, surface smooth. Rostrum short, about 0.2 carapace length, with median sulcus, ascending, tip rounded. Carapace spines: 1 median in anterior third of carapace; antennal moderate; hepatic moderate, with short oblique supporting carina, anterior to median; branchiostegal strong with supporting carina, almost to end of basicerite of antenna; pterygostomian moderate; lateral margin of rostrum extending posteriorly over orbital fissure as ridge almost to center of carapace. Band around ventral margin of carapace, widening to lobe adjacent to bases of pereiopods I and II. Eye moderately large, cornea well developed, weak tubercle. Antennule: peduncle moderately long, third segment subequal to second; stylocerite short; outer flagellum extending to about end of antennal scale, inner longer. Antenna: scale 0.8–1.0 carapace length, as long as or slightly shorter than telson, tip of lamella rounded, spine exceeding lamina somewhat; basicerite, 2 lateral spines; peduncle moderately long; flagellum shorter than body. Third maxilliped: moderately long, slender; exopod short, with lash. Pereiopods: I longer than third maxilliped, stout; merus, inner spine in proximal half, strong distal spine; propodus oblong, moderately long, 2.6–3.0 average width, fixed finger moderate, slender; dactylus, when flexed obliquely, transverse; II about as long as I, slender; chelate; III longer than II, slender; dactylus slender, about 0.55 length of propodus; IV longer than III, slightly stouter; dactylus slender, about 0.8 propodus length; V about as long as IV, similarly stout; dactylus about 0.8 propodus length. Abdomen: ventral margins of pleura of first and second somites concave; fifth, faint dorsal median carina, short transverse sulcus at anterior end; sixth, faint median dorsal sulcus, moderate posteroventral spine, ventral sulcus; telson narrow, tapering to acute tip, dorsal distal flattened, 2 lateral spines, evenly spaced with respect to tip of telson; inner uropod narrower, as long as or longer than outer, former reaching tip of telson.

Remarks The category *C. alaskensis elongata,* established by Rathbun (217), was mentioned earlier. She reported that specimens from British Columbia and Puget Sound to southern California differed from the typical *C. alaskensis* as follows: longer and narrower rostrum; outer antennular flagellum not reaching tip of antennal scale; longer antennal scale, as long as carapace; faint dorsal median carina on fourth somite; tip of telson more acute. The present author has examined specimens caught by the *Albatross* off Cape Flattery (station 2872), and identified by Rathbun as *C. a. elongata.* When compared with specimens of the typical species, some slight differences were found and there was overlap of characters. This appears to corroborate Rathbun's statement that the typical *C. alaskensis,* "passes by insensible gradations into a form occurring off the coast of California and Oregon." Subsequent authors (232, 185, 290) have identified collections from southern areas as *C. a. elongata* but, the opinion of the present author is that recognition of a separate subspecies in southern British Columbia and northern Washington waters is not justified. It is to be hoped that the status of *C. a. elongata* will be reexamined in the future.

Color Light brownish gray background over almost entire shrimp, lighter on most appendages; closely spaced dark gray and brown spots over body, pleopods, pereiopods, all parts of antenna; on carapace and abdomen, scattered spots of pale yellow, white, and light brown; also pale yellow spots on antennal peduncle, proximal segments of pereiopods II, IV, and V, basipodites of pleopods; dense covering of fine black dots on posterior midline of carapace, around posterior margin of sixth somite, on telson and uropods; tip of inner uropod orange. Specimen illustrated (Plate 3E) was collected near La Perouse Bank, at 97-99 m; intertidally and in the shallow sublittoral, individuals are generally lighter in color with tail fan as black, but without orange spot on inner uropod.

Distinctions *C. alaskensis* is often confused with *C. nigricauda.* Main distinguishing characters of former are generally slender body; tip of lamella of antennal scale more or less rounded, exceeded markedly by spine; antennal scale normally as long as telson, sometimes a little shorter; outer antennular flagellum slightly longer than tip of lamina of antennal scale; uropods and telson all about same length.

Maximum lengths Males: carapace 10.9 mm, total 52 mm; females: carapace 14.7 mm, total 65 mm.

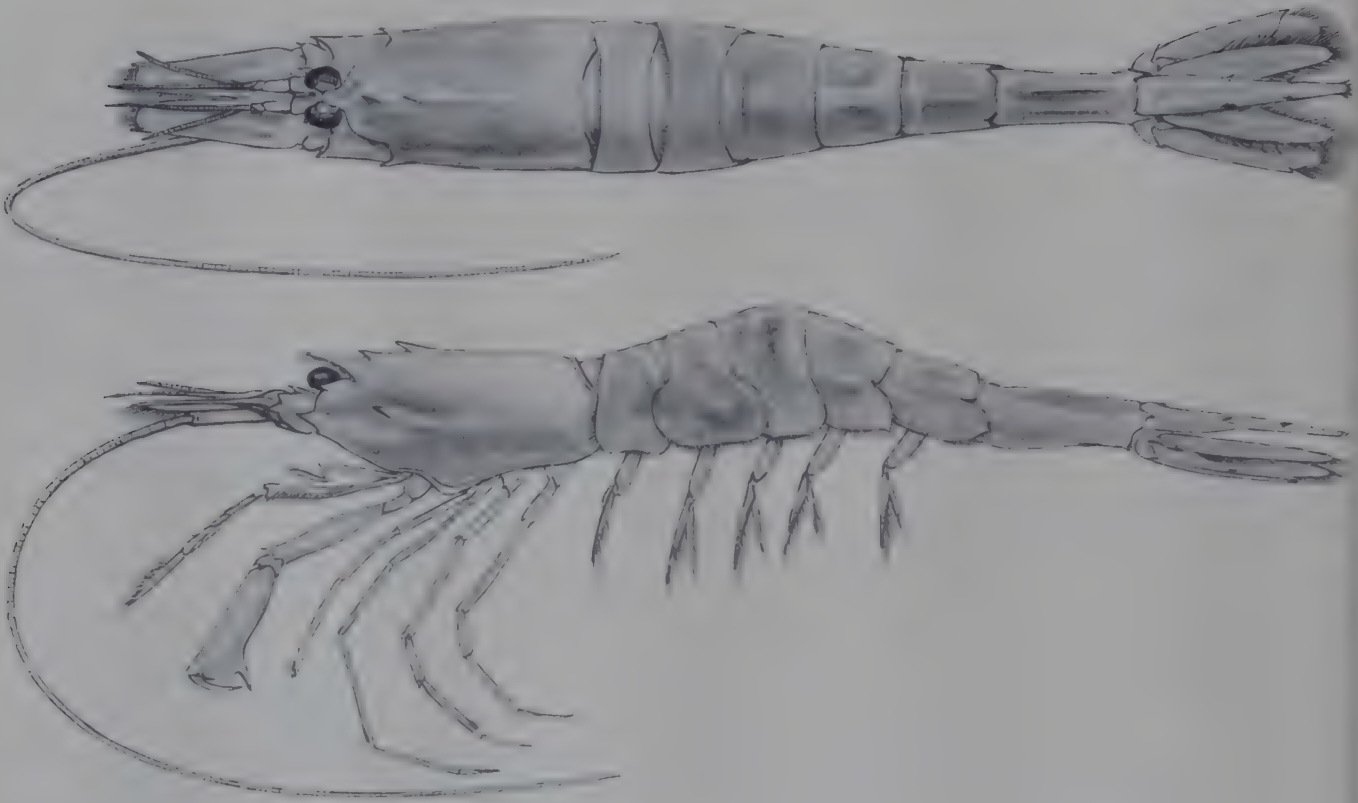
Range Bering Sea to Puget Sound; Kurile Islands (219); intertidal to 275 m. Maximum depth above, that of trawl tow in Strait of Georgia, Dec. 11, 1963.

There is a good possibility that some specimens listed as *Crangon vulgaris* in early collections (172, 242) were *C. alaskensis.* Two *Albatross* stations, No. 2863 and Sucia Island (219), were actually in United States waters (285). A collection of specimens in Departure Bay and Hecate Strait was reported (258).

Biology and economics This probably is the most common local crangon in the shallow sublittoral zone (5-50 m). It is apparently able to tolerate a wide range of salinities, occurring at 13 intertidal stations (2 near river mouths) in southeastern Alaska and Prince William Sound, at salinities 2.2-32.7‰; corresponding temperatures were 7.3-14.3°C (250, 43). Ovigerous females, 8.0-13.6 mm carapace length, were found locally in May, June, July, August, and October. Egg dimensions were reported as 0.75 × 0.55 mm (298). Larval stages of this shrimp are known from a laboratory rearing (173). A parasite is the branchial isopod, *Argeia pugettensis* (225, 100).

COMMON TWO-SPINED CRANGON

Crangon communis Rathbun, 1899



Description Body slender, depressed. Shell thin, pubescence on anterior part of carapace, and in abdominal sulci. Rostrum short, about 0.2 carapace length, median sulcus, ascending, tip rounded. Carapace spines: 2 median in anterior half of carapace, anterior spine slightly smaller; median dorsal carina, ahead of anterior spine extending to posterior half of carapace; antennal moderate, with supporting carina; branchiostegal strong, with carina; pterygostomian weak; hepatic strong; lateral margin of rostrum extending posteriorly over orbital fissure as ridge above and beyond hepatic spine. Eye moderately large, cornea well developed, weak tubercle. Antennule: peduncle short, second segment over twice length of second, latter with dorsal distal lobe; stylocerite short; inner flagellum longer than outer, and extending beyond antennal scale. Antenna: scale shorter than telson, spine exceeding lamella; basicerite, upper lateral lobe, lower oblique spine; peduncle long; flagellum about as long as body. Third maxilliped: long, slender; distal part of antepenultimate segment twisted; exopod long, with lash. Pereiopods: I as long as third maxilliped, stout except ischium, and merus proximally; merus, strong distal spine; carpus, 2 weak distal spines; propodus widens distally, 3.3–3.7 average width, fixed finger long and stout; dactylus, when flexed, obliquely transverse; II shorter than I, slender; chelate; III longer than II, as slender; dactylus slender, about 0.5 propodus length; IV shorter than III, stouter; dactylus slender, about 0.65 propodus length; V shorter than IV, slightly stouter; dactylus slender, about 0.8 propodus length. Abdomen: all sulci filled with sparse short pubescence easily rubbed off; first and second somites, each with long transverse sulcus; third to fifth, each with wide median dorsal carina; third, with anterior transverse sulcus through carina, wide vertical sulcus below carina; fourth, 2 transverse sulci, one at each end of carina; fifth, anterior transverse sulcus through carina, wide sulcus or depression each side of carina; pleuron of fourth, moderate posteroventral spine; fifth pleuron, moderate posterolateral spine; sixth, 2 median dorsal carinae, a sulcus on outer side of each carina, weak posteroventral spine; telson moderately wide, tapering to rounded tip, median sulcus, 2 pairs dorsolateral spines; inner uropod longer than outer, neither reaching end of telson.

Remarks The 2 spines referred to in the common name are the median spines on the carapace.

Color Medium gray background over most of body; more or less uniform brown over branchial region of carapace, overlaid with pale yellow spots, fine brown to charcoal dots over rest of carapace; abdomen has brown spots and blotches, light yellow spots, more intense along midlateral line of first to fourth, and sixth somites; ventral margins of all somites bordered by magenta mottling; magenta on pleopods, and chela of pereiopod I, which also has brown spots; other pereiopods with magenta to rust patches; latter color repeated distally on antennal flagellum; brown spots on telson and uropods, outer margin of outer uropod magenta (Plate 5D).

Distinctions Separated from other species of *Crangon* with 2 median spines and lacking an inner spine on merus of pereiopod I, by presence of pubescence on carapace and in abdominal sulci; slightly ascending rostrum with rounded tip.

Maximum lengths Males: carapace 12.5 mm, total about 61 mm; females: carapace 16.9 mm, total 80 mm.

Range Chukchi Sea (266, 174); Bering Sea, to San Diego, CA (219); Okhotsk Sea (265); Sea of Japan, to Peter the Great Bay (266); east coast of Honshu Island (297); 16–1537 m. Maximum depth at *G. B. Reed* station off Washington coast (47.52′N, 125.57′W), 1537 m, Sept. 5, 1968.

The first known published reference (212) to *C. communis* on the west coast of Canada was as the host of the rhizocephalan parasite *Mycetomorpha vancouverensis,* found in Departure Bay, August 1911.

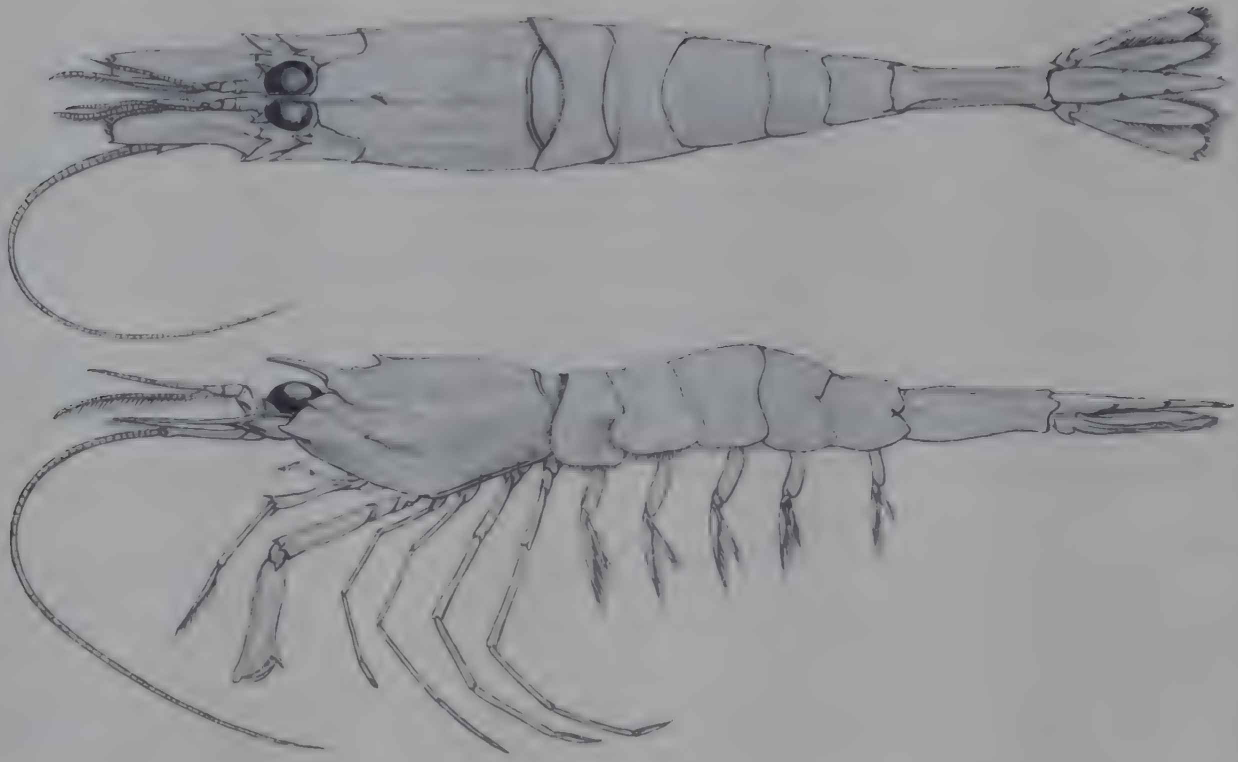
Biology and economics This species may rank as the most common local shrimp. It occurs coastwide on mud bottoms from the shallow sublittoral to the lower continental slope. On grounds where *Pandalopsis dispar, Pandalus jordani,* and *P. borealis* are trawled commercially, *C. communis* is the most abundant associated shrimp species. In addition to capture by bottom trawls, it also has been collected by midwater trawls. At 1 locality off Active Pass at maximum depths 128–161 m, specimens were caught at intermediate depths 20–67 m (260).

Ovigerous females, 9.1–13.9 mm carapace length, occurred in January, February, May, and June to September. The first stage larva was described, as hatched from a female caught in the Bering Sea in April (143). Estimated number of eggs was 2200, and egg dimensions were 0.9 × 0.75 mm (298). Known parasites are the branchial isopod, *Argeia pugettensis* (225, 100), and the rhizocephalan, *Mycetomorpha vancouverensis* (212, 223) (Fig. 3D).

C. communis was caught in a beam trawl at 4 localities in southeastern Alaska and Prince William Sound, at 46–121 m (250, 43). In the eastern Bering Sea, collections were made at 62–95 m, on mixed mud and sand bottoms, at temperatures 0.5–3.6°C (187).

ABYSSAL CRANGON

Crangon abyssorum Rathbun, 1902



Description Body slender, depressed. Shell very thin, smooth. Rostrum short, about 0.3 carapace length, ascending, slightly curved, very narrow, tip acute. Carapace spines: 2 median both in anterior third of carapace, anterior one much smaller; antennal strong, with supporting carina extending obliquely to hepatic spine; hepatic strong, supported by short oblique carina; branchiostegal strong with supporting carina; pterygostomian obsolescent; lateral margin of rostrum extending over orbital fissure as ridge over and beyond hepatic spine, almost to posterior margin; dorsal median carina from rostrum almost to posterior margin. Eye large, cornea well developed, flat inner surfaces, both eyes contiguous. Antennule: peduncle moderately long, second segment about twice length of third, distal part of appendage held above antennal scale by deflection at distal end of first segment; stylocerite short, suberect; both flagella extending beyond antennal scale, inner longer, setiferous. Antenna: scale shorter than telson, spine exceeding lamella, outer margin concave proximally; peduncle long; flagellum about body length. Third maxilliped: long, slender; exopod short, with lash. Pereiopods: I about as long as third maxilliped, stout; merus, strong distal spine; carpus, strong distal spine; propodus widens distally, 3.5–4.2 average width, fixed finger strong; dactylus, when flexed, obliquely transverse; II shorter than I, very slender; chelate; III longer than II, as slender; dactylus about 0.4 propodus length; IV longer than III, slightly stouter; dactylus slender, slightly flattened, about 0.5 propodus length; V longer than IV, as slender; dactylus slender, slightly flattened, about 0.5 propodus length. Abdomen: lower posterior part of pleuron of first somite depressed to accommodate overlap of second somite; third and fifth, each with faint anterior transverse sulcus; sixth, 2 prominent dorsal carinae, dorsal proximal prominence, blunt carina along anterior half of lateral margin; telson narrow, tapering to acute tip, median dorsal sulcus, 2 pairs dorsolateral spines; inner uropod longer and narrower than other, both shorter than telson.

Color Unavailable.

Distinctions Distinguished by very thin shell; large contiguous eyes; deflected antennular peduncle; relatively long, very narrow rostrum.

Maximum lengths Males: carapace 14.1 mm, total 64 mm; females: carapace 14.5 mm, total 63 mm.

Range Bering Sea to Cortes Bank, CA (219); east of Kurile Islands (38), east coast of Japan (297); 97–2975 m (38).

First taken on the British Columbia coast by the *Albatross,* west of Queen Charlotte Islands at 1603 m, Aug. 29, 1888 (station 2860) (219).

Biology and economics Three ovigerous females, 12.5–14.1 mm carapace length, were captured off Queen Charlotte Sound at 2200 m, Sept. 11, 1964. Reportedly, the egg count was 61, and egg dimensions, 0.75 × 0.6 mm (298).

Genus *Metacrangon* Zarenkov, 1965

Rostrum present. Flagellum of antenna setiferous (British Columbia specimens). Gastric region depressed below general level of carapace. Two median spines on carapace, also one submedian on each side. Branchiostegal and pterygostomian spines present, though latter sometimes weak. Posteroventral angles of sixth abdominal somite flared strongly as winglike lobes. On male, endopod of second pleopod longer than appendix masculina. Pleurobranchia on each of five pereiopods; epipods and exopods on first to third maxillipeds; epipod on second pereiopod (British Columbia and New Zealand specimens). Females carry few (< 50), relatively large eggs (292, 298).

Zarenkov (298), in establishing this genus, removed species from the genera *Sclerocrangon* G. O. Sars. e.g. *M. jacqueti* (A. Milne Edwards, 1881), an Atlantic species; and *Crangon* s.l., e.g. *M. variabilis* (Rathbun, 1902). The latter was set as the type species of the genus. His proposal appears quite valid, based on the morphology of the four local species, *M. spinosissima, M. variabilis, M. munita,* and *M. acclivis.* In this author's opinion, the main diagnostic characters setting *Metacrangon* apart from one or both of the other genera are: main endopod of first pleopod of male longer than appendix masculina (*Sclerocrangon* s.s. p. 8); gastric region depressed below rest of carapace (*Crangon* s.s., slight depression in *Sclerocrangon* s.s.); flagellum of antenna distinctly setiferous (both genera); flaring of posteroventral angles of sixth somite (*Crangon* s.s., slight flaring in some species of *Sclerocrangon* s.s.). All species of *Metacrangon* (about 19 designated by Zarenkov) live in northern temperate and subarctic regions except three species, described from the southern hemisphere. *M. knoxi* (Yaldwyn, 1960) and *M. richardsoni* (Yaldwyn, 1960) are found off New Zealand (292), and *M. bellmarleyi* (Stebbing, 1914) is a South African species (21). All three species had been placed in *Sclerocrangon* s.l. (292). These species agree well in general morphology with local species of *Metacrangon.* Females of species of the genus bear relatively few large eggs, but the mode of larval development is apparently unknown.

Species of both *Metacrangon* and *Mesocrangon* are termed "spinyheads" to call attention to the presence of median and submedian spines as well as other spines on the carapace (Fig. 16).

Metacrangon acclivis (Rathbun, 1902), the forked spinyhead, occurs in British Columbia waters; however, because its identity was not confirmed (comparison with a specimen from the U.S. National Museum, USNM 26801) until late in the preparation of this Bulletin, no detailed description is provided. Two females, 6.2 and 7.0 mm carapace length, were collected by trawling with *G. B. Reed,* off La Perouse Bank, 207–218 m, Feb. 7, 1972. The larger specimen had a parasite, identified as the rhizocephalan, *Mycetomorpha vancouverensis.* The common name given to this shrimp refers to the forklike appearance of the closely spaced rostrum and anterior median spine, when viewed laterally (see fourth diagram in key below).

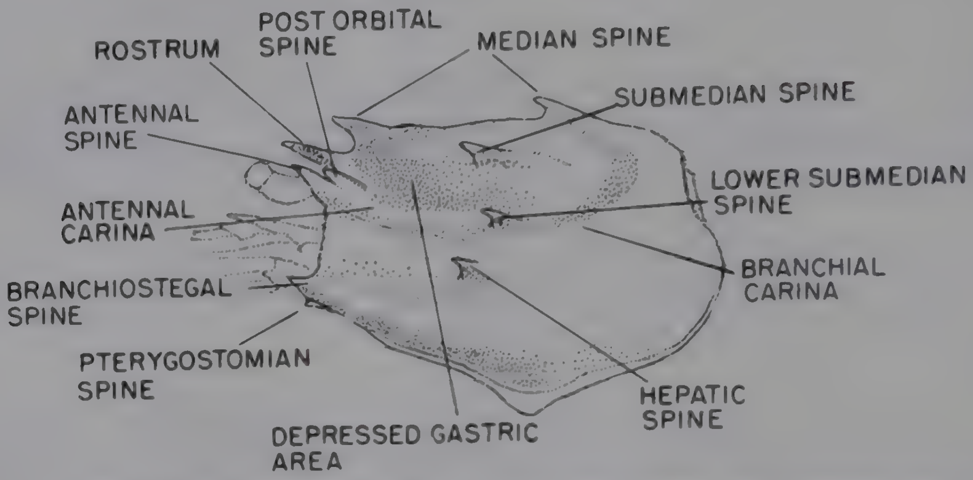
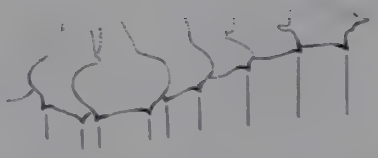

ROSTRUM
POST ORBITAL SPINE
MEDIAN SPINE
SUBMEDIAN SPINE
ANTENNAL SPINE
LOWER SUBMEDIAN SPINE
ANTENNAL CARINA
BRANCHIAL CARINA
BRANCHIOSTEGAL SPINE
PTERYGOSTOMIAN SPINE
HEPATIC SPINE
DEPRESSED GASTRIC AREA

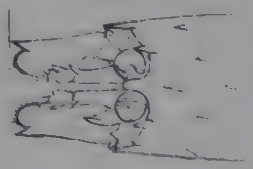
FIG. 16. Hypothetical carapace of a spinyhead, showing terms used in species accounts.

Key to species of genus *Metacrangon*

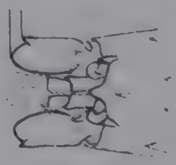


1 One or 2 ventral spines on pleura of first to fifth somites .... Southern spinyhead, *M. spinosissima* (p. 115)

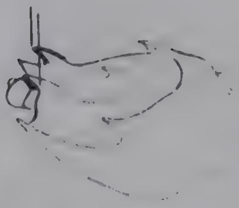
Spine on pleuron of fifth, sometimes on fourth 2



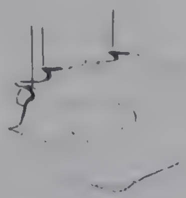
2 Spine of antennal scale reaches or exceeds lamella; prominent dorsal median carina on each of third to fifth somites .... Deepsea spinyhead, *M. variabilis* (p. 117)



Lamella of antennal scale exceeds spine; dorsal surfaces of third to fifth somites smooth, or faintly carinated 3



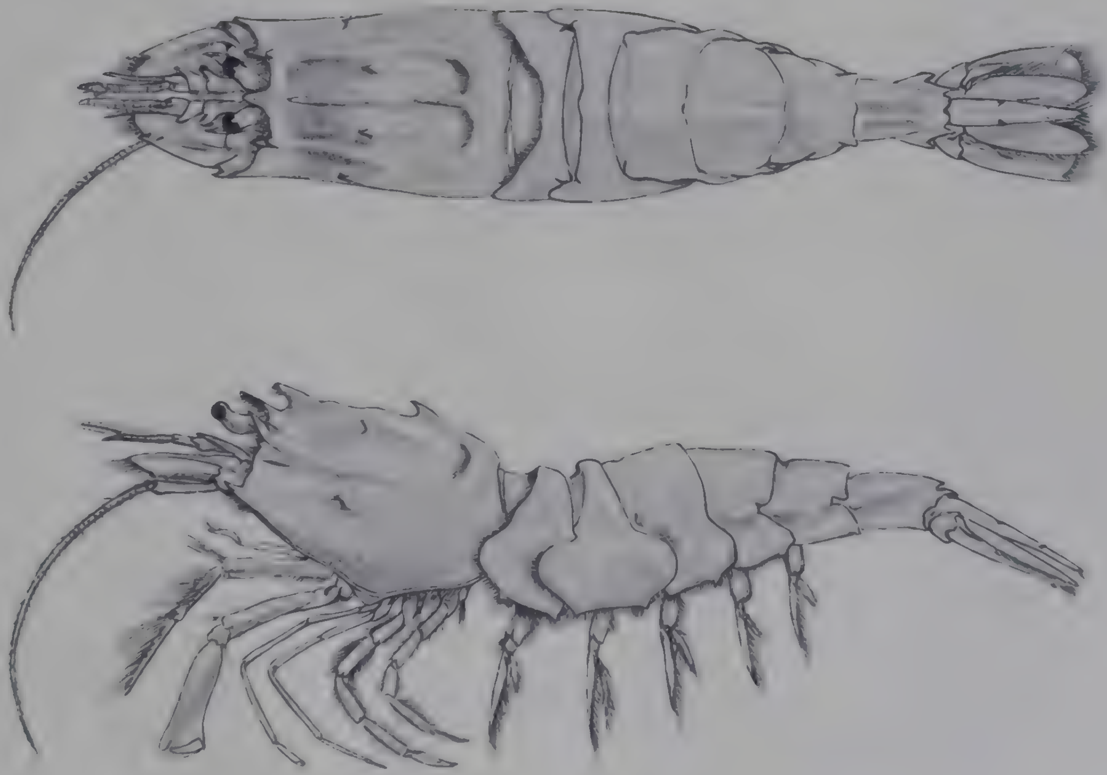
3 Anterior median spine on carapace obliquely erect, larger than posterior, tip of former extending beyond orbital margin .... Forked spinyhead, *M. acclivis* (p. 113)



Two median spines about same size, tip of anterior spine well behind orbit .... Coastal spinyhead, *M. munita* (p. 119)

SOUTHERN SPINYHEAD

Metacrangon spinosissima (Rathbun, 1902)



Description Body stout, depressed. Shell thick, mainly rugose, depressed portion of carapace pubescent. Rostrum short, 0.15–0.2 carapace length, median sulcus, ascending, tip acute or rounded. Carapace spines: 2 median, anterior larger, just posterior to rostrum, posterior in posterior half of carapace, the 2 joined by a median carina; submedian, about center of carapace, with supporting carina; hepatic with supporting carina; antennal strong, ascending; postorbital moderate, confluent with antennal; weak spine below antennal; branchiostegal strong, with supporting carina; pterygostomian weak; fine carina extending from slight fissure below antennal spine posteriorly across depression in carapace. Band around ventral margin of carapace, widening as pronounced lobe adjacent to base of pereiopod II or III. Eye small, cornea well developed, stalk tapers distally, deflected obliquely. Antennule: peduncle long, second segment longer than third, first and second each with distal lateral spine; stylocerite moderately long, broad, pointed laterally; inner flagellum longer than outer, both exceed antennal scale. Antenna: scale shorter than telson, lamella exceeds spine; basicerite, 2 blunt lateral spines; peduncle long; flagellum longer than body, with plumose setae. Third maxilliped: moderately long, slender, except antepenultimate segment, setiferous; exopod long, with lash. Pereiopods: I longer than third maxilliped, stout; merus, ventral longitudinal carina; propodus widens distally, 3.6–4.0 average width, fixed finger moderate; dactylus, when flexed, obliquely transverse; II longer than I, slender; chelate; III longer than II, as slender; dactylus slender, about 0.44 propodus length; IV shorter than III, moderately stout, setiferous; dactylus flattened, about 0.9 propodus length; V shorter than IV, moderately stout, setiferous; dactylus flattened, about 0.55 propodus length. Abdomen: pleura of first 3 somites each with 2 ventral spines; fourth to sixth each with moderate posteroventral spine; sixth with strong spine at dorsoposterior margin; depressions in pleura of first and third somites to accommodate pleuron of second; first to third somites each with faint median dorsal carina; dorsal anterior margin of first deeply concave; second with dorsal transverse furrow, adjacent anterior margin produced, forming slight hood over furrow; third with dorsal transverse sulcus through median carina; dorsal median carina on posterior half of fourth, lateral carina in line with articular knobs; fifth with transverse sulcus through anterior end of faint median dorsal carina, lateral carina extending to middle of somite from articular knob; sixth, 2 prominent dorsal carinae, shorter than somite, lateral carina extending obliquely from articular knob toward dorsal margin; posteroventral regions of sixth flared strongly giving a winglike appearance in dorsal view; telson narrow, tapering to acute tip, median dorsal sulcus, 2 pairs widely spaced dorsolateral spines; inner uropod longer than outer, and exceeding tip of telson.

Remarks The deeply concave anterior dorsal margin of the first abdominal somite, and slightly hooded transverse furrow on second somite apparently are adaptations enabling this shrimp to assume the defensive cataleptic position, as in *Argis levior* (p. 89) and *Lebbeus schrencki* (p. 185).

Color Background of body and appendages buff; on carapace, brownish mottling blending with background on posterior branchial region; other brown patches at bases of median spines and bordering anterolateral margin; on abdomen, light brown patches on pleura of first to third somites, also darker areas dorsally on first somite and lateral surfaces of fourth to sixth somites, which border conspicuous light swath and rectangular patch near ventral margin of second pleuron; light brown transverse bars on telson and inner uropod; pleopods, light red to pink; third maxilliped and pereiopods I, IV, and V, light rust; latter appendages, anterolateral margin of carapace, and anterior appendages, with light rust setae (Plate 1B).

Distinctions Separated from other species in the genus by 1 or 2 ventral spines on each of first to fifth pleura; anteriorly on second somite a transverse furrow, with adjacent margin produced as slight hood over furrow.

Maximum lengths Males: carapace 7.3 mm, total 30 mm; females: carapace 12.5 mm, total 54 mm.

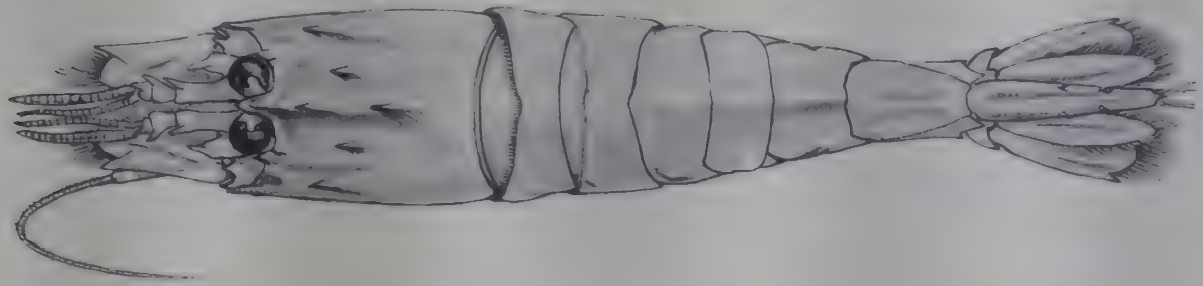
Range Nootka Sound, and northern Strait of Georgia, to Isla San Martin, Baja California (282); 28 m (282) to 220 m. Maximum depth at trawling locality in Howe Sound, Dec. 12, 1963.

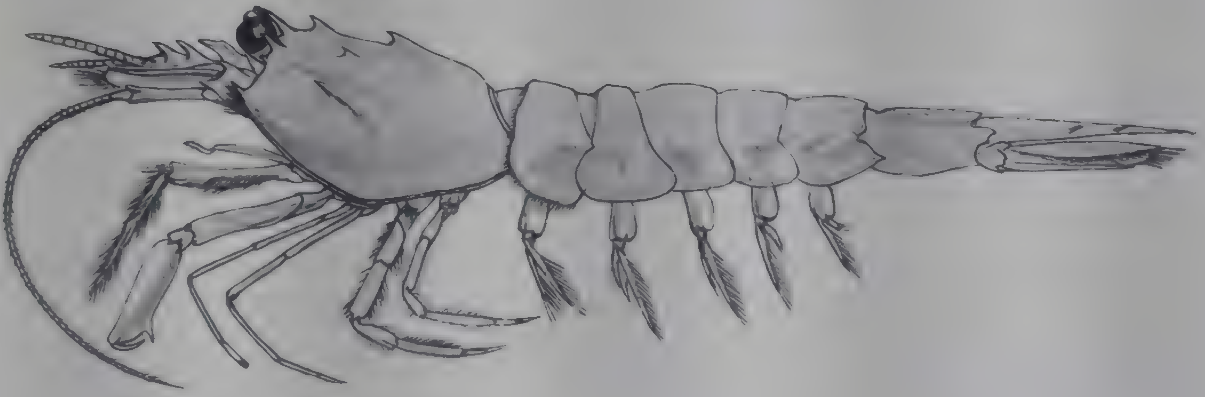
The first known capture of *M. spinosissima* in British Columbia waters was that of an ovigerous female in English Bay at 36 m, Aug. 20, 1948 (50).

Biology and economics The species is fairly common in the southern Strait of Georgia and along the southwest coast of Vancouver Island. Most specimens have been trawled on mud bottoms, 97–157 m. Ovigerous females, 9.9–12.3 mm carapace length, were present during February, March, April, and August.

DEEPSEA SPINYHEAD

Metacrangon variabilis (Rathbun, 1902)





Description Body moderately stout, depressed. Shell thick, mainly rugose, depressed portion of carapace pubescent. Rostrum short, about 0.2 carapace length, median sulcus, ascending, tip rounded. Carapace spines: 2 median, anterior slightly larger, posterior in posterior half of carapace, and the 2 joined by median carina; submedian moderate, just anterior to center of carapace; hepatic strong, with oblique supporting carina; postorbital weak; antennal strong, ascending with short supporting carina; weak spine below antennal; branchiostegal strong, with supporting carina; pterygostomian weak; fine carina extending from slight fissure above antennal spine across depression in carapace. Band around ventral margin of carapace, widening as pronounced lobe adjacent to base of pereiopod II or III. Eye moderate, cornea well developed, strong tubercle. Antennule: peduncle long, second segment twice length of third, all segments each with strong, distal, lateral spine; stylocerite short, broad base tapering to blunt tip; both flagella about same length, extending well beyond antennal scale. Antenna: scale shorter than telson, spine may or may not extend beyond lamella, outer margin concave; basicerite, 2 strong lateral spines; peduncle long; flagellum shorter than body, with plumose setae. Third maxilliped: moderately long, slender, except antepenultimate segment, setiferous; exopod moderately long, with lash. Pereiopods: I longer than third maxilliped, stout; merus, 2 distal spines; carpus, 2 strong distal spines; propodus oblong, 3.0–3.6 average width, fixed finger moderate; dactylus, when flexed, obliquely transverse; II slightly shorter than I, very slender; chelate; epipod; III longer than II, slightly stouter; dactylus slender, about 0.55 propodus length; IV shorter than III, stout, setiferous; dactylus slightly flattened, about 0.75 propodus length; V shorter than IV, less stout; dactylus slightly flattened, about 0.75 propodus length. Abdomen: first to fifth somites each with median dorsal carina, those on first and second may be weak or absent; fourth, strong posteroventral spine; fifth, strong posterolateral spine; sixth, 2 prominent dorsal carinae, shorter than somite, lateral carina extending obliquely from articular knob; moderate posteroventral spine, posteroventral regions of sixth strongly flared giving winglike appearance in dorsal view; telson moderately wide, tapering to acute tip, median dorsal sulcus, 2 pairs lateral spines; inner uropod longer than outer, former reaches end of telson.

Remarks It was not possible to examine enough specimens to provide corroboration of variations (219) in the following characters: shape of rostrum, length of chela of pereiopod I, and prominence of dorsal median carinae on abdominal somites. Her opinion was that variations were not constant enough to warrant separation of the species.

Color Transparent overall, with grayish tinge; fine branching orange-brown and gray-brown chromatophores over body, antennal peduncle, third maxilliped, and pereiopod I (Plate 5F).

Distinctions Distinguished from other spinyheads by prominent dorsal median carina on each of third to fifth somites; spine of antennal scale reaching or exceeding lamella; pleura of first to third somites lack spines; fifth pereiopod with somewhat fewer setae than fourth.

Maximum lengths Males: lengths unavailable; females: carapace 9.3 mm, total 38 mm maximum lengths of specimen in United States National Museum, USNM 26701.

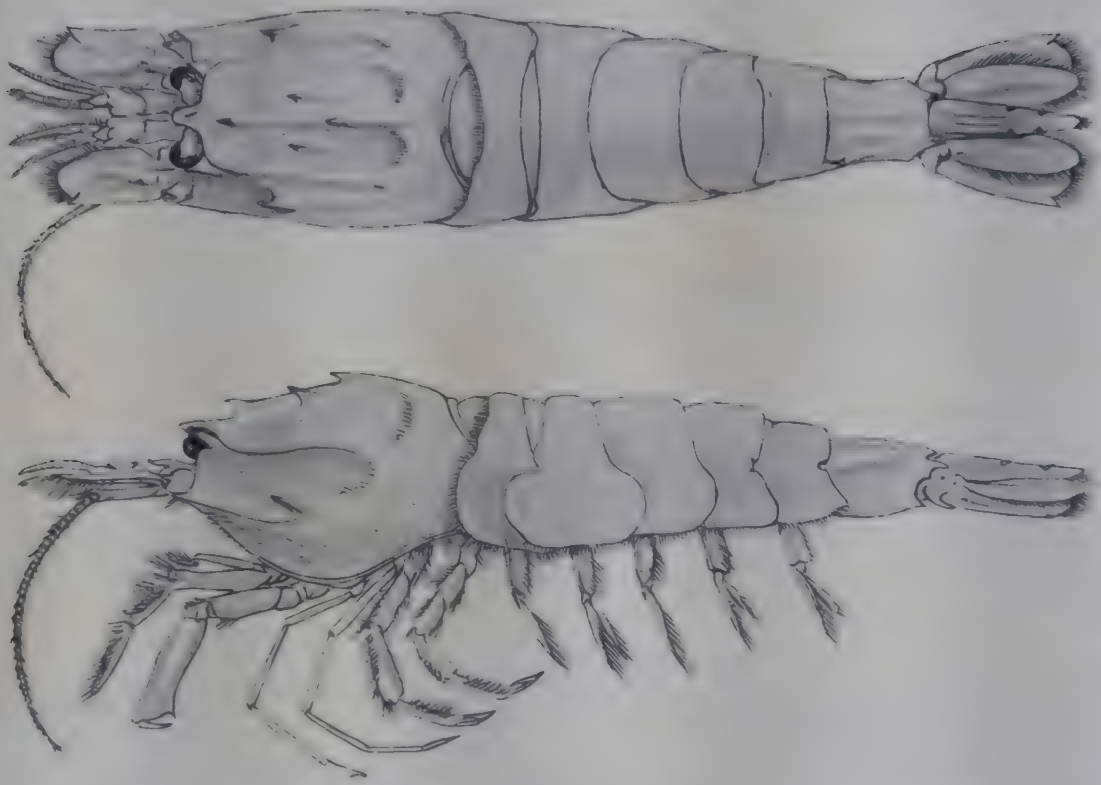
Range Commander (266) and Pribilof Islands, Bering Sea to San Nicolas Island; 92–1271 m (219).

In British Columbia waters the first and only known capture was that of a male specimen, by *G. B. Reed* in trawl, off Anthony Island, 1230–1135 m, Feb. 18, 1972.

Biology and economics The above locality was in a submarine canyon where *Lebbeus washingtonianus* (p. 183) was collected Sept. 17, 1971. *M. variabilis* was collected at 18 *Albatross* stations (219); positions (263) of 13 of these, plotted on U.S. hydrographic charts, showed that at only station 3340, southeast of Chirikof Island at 1272 m, was the species found in a submarine basin. An egg count was 29, and egg dimensions were 2.3 × 2.2 mm (298). A parasite is the rhizocephalan, *Mycetomorpha vancouverensis* (223).

COASTAL SPINYHEAD

Metacrangon munita (Dana, 1852)



Description *Female* Body stout, depressed. Shell thick, mainly rugose, depressed portion of carapace pubescent. Rostrum short, about 0.15 carapace length, median sulcus, horizontal, tip broadly rounded. Carapace spines: 2 median about equal, anterior in anterior third of carapace, posterior behind middle of carapace; dorsal median carina from anterior spine to almost posterior margin; submedian just ahead of middle of carapace, strong, with supporting carina; hepatic strong, ahead of submedian, with supporting carina; lateral margin of rostrum extending posteriorly over orbital fissure as ridge to posterior margin of depression; antennal moderate; small spine below antennal very weak or obsolescent; branchiostegal strong, its carina merging with lower margin of depression; pterygostomian spine weak. Band around ventral margin of carapace widening as lobe adjacent to pereiopod II; in profile, dorsal margin of carapace descending from posterior median spine to rostrum. Eye small, cornea well developed, strong tubercle. Antennule: peduncle long, third segment less than half length of second, first and second each with blunt dorsal distal spine; stylocerite short, formed of upper thick rib extending forward as spine, and laminar lower portion; flagella about equal, exceed antennal scale, inner setiferous. Antenna: scale shorter than telson, wide, lamella exceeding spine; basicerite, 2 blunt lateral spines; peduncle long; flagellum shorter than body, with plumose setae. Third maxilliped: moderately long, moderately stout, setiferous; exopod long, with lash. Pereiopods: I shorter than third maxilliped, stout; carpus, distal spine; propodus oblong, 3.2–4.0 average width, fixed finger small; dactylus, when flexed, obliquely transverse; II longer than I, slender; chelate; III longer than II, as slender; dactylus slender, about 0.7 propodus length; IV shorter than III, stout, setiferous; dactylus somewhat flattened, about 0.7 propodus length; V shorter than IV, more slender, setiferous; dactylus somewhat flattened, about 0.7 propodus length. Abdomen: pleura of first and third somites each with lower lateral depression to accommodate second pleuron; fourth, very faint median dorsal carina, or lacking; fifth, faint median carina, short transverse sulcus, blunt posterolateral spine; sixth, 2 median dorsal carinae, shorter than somite, and lateral carina extending from articular knob towards dorsal margin; strong posterodorsal spine, moderate posteroventral spine, posteroventral parts of sixth strongly flared, giving winglike appearance in dorsal view; telson moderately wide, tapering to acute tip, median dorsal sulcus, 2 pairs dorsolateral spines; uropods about equal, not extending beyond tip of telson. *Male* Dorsal profile of carapace more horizontal, descending only from anterior median spine to rostrum; median carina prominent to posterior margin of carapace; both median spines stronger; tip of submedian spine well below dorsal profile of carapace; small spine below antennal spine stronger; branchiostegal spine more prominent and directed laterally; rostrum bladelike; lateral margin of carapace extending posteriorly less prominently; third maxilliped relatively shorter; and antennal flagellum has few setae, most on proximal half.

Remarks A female specimen of *M. richardsoni* from New Zealand was similar to *M. munita* (292). One difference was absence on the former of small spine on anterolateral margin of carapace.

Color Unavailable.

Distinctions *M. munita* is separated by gastric region depressed below most of carapace; lack of median dorsal carinae on first to third somites, and possibly fourth; lack of spines on all pleura except fifth; rostrum horizontal, relatively wide, tip broadly rounded.

Maximum lengths Males: carapace 8.0 mm, total 33 mm; females: carapace 12.3 mm, total 48 mm.

Range Port Etches, AK, to San Miguel Island, CA, (219); 13–230 m.

First caught on the west coast of Canada by the *Albatross*, northwest of Barkley Sound at 62 m, Sept. 25, 1888 (station 2879) (219).

Biology and economics Recent records suggest that this species is not as common as reported (258), but the collecting localities may not be comparable. An ovigerous female, 10.0 mm carapace length, was caught in a prawn trap in Kingcome Inlet at 22–26 m, Nov. 21, 1973. The branchial isopod, *Argeia pugettensis*, is a parasite (225, 100).

Genus *Mesocrangon* Zarenkov, 1965

Rostrum relatively short and wide, median sulcus, tip broadly rounded. Gastric region depressed, or level with rest of carapace. Carapace spines: 1 or 2 median present; submedian spine present; lower submedian present or absent; postorbital, antennal, branchiostegal, and pterygostomian all present, though last sometimes weak. Posteroventral angles of sixth abdominal somite not flared as winglike lobes. Arthrobranch gill on third maxilliped absent. On male, distal part of endopod of second pleopod longer than appendix masculina. Females carry 50–100 relatively small eggs.

Zarenkov (298) established the genus *Mesocrangon* to accommodate three species, *M. munitella, M. intermedia* (Stimpson, 1860) (254), and *M. volki* (Birshstein and Vinogradov, 1953) (37), intermediate between *Crangon* and *Metacrangon* in morphology and mode of reproduction. Concerning *Mesocrangon*, Zarenkov assumed a complete cycle of five larval stages, and this was confirmed by Makarov (176) for *M. intermedia*, though larvae were larger and more advanced than those of species of *Crangon* at corresponding stages, and the entire larval life was shorter.

The capture of *M. intermedia* northwest of Amphitrite Point at 44 m, Sept. 25, 1888 (*Albatross* station 2881), was recorded (219). There is no known subsequent record in Canadian waters, nor apparently off the coasts of Washington and Oregon. Through an oversight the species has not been described and illustrated here. In the event of a reoccurrence, it is included with *M. munitella* in the key below, under the common name northern spinyhead. Superficially, *M. intermedia* resembles *Crangon communis* by its body shape, the presence of 2 median carapace spines, and median dorsal carinae on abdominal somites. It differs mainly from *C. communis* by submedian spines on the carapace; a spine on the inner surface of the merus of pereiopod I; and the posterior median spine at the middle of the carapace.

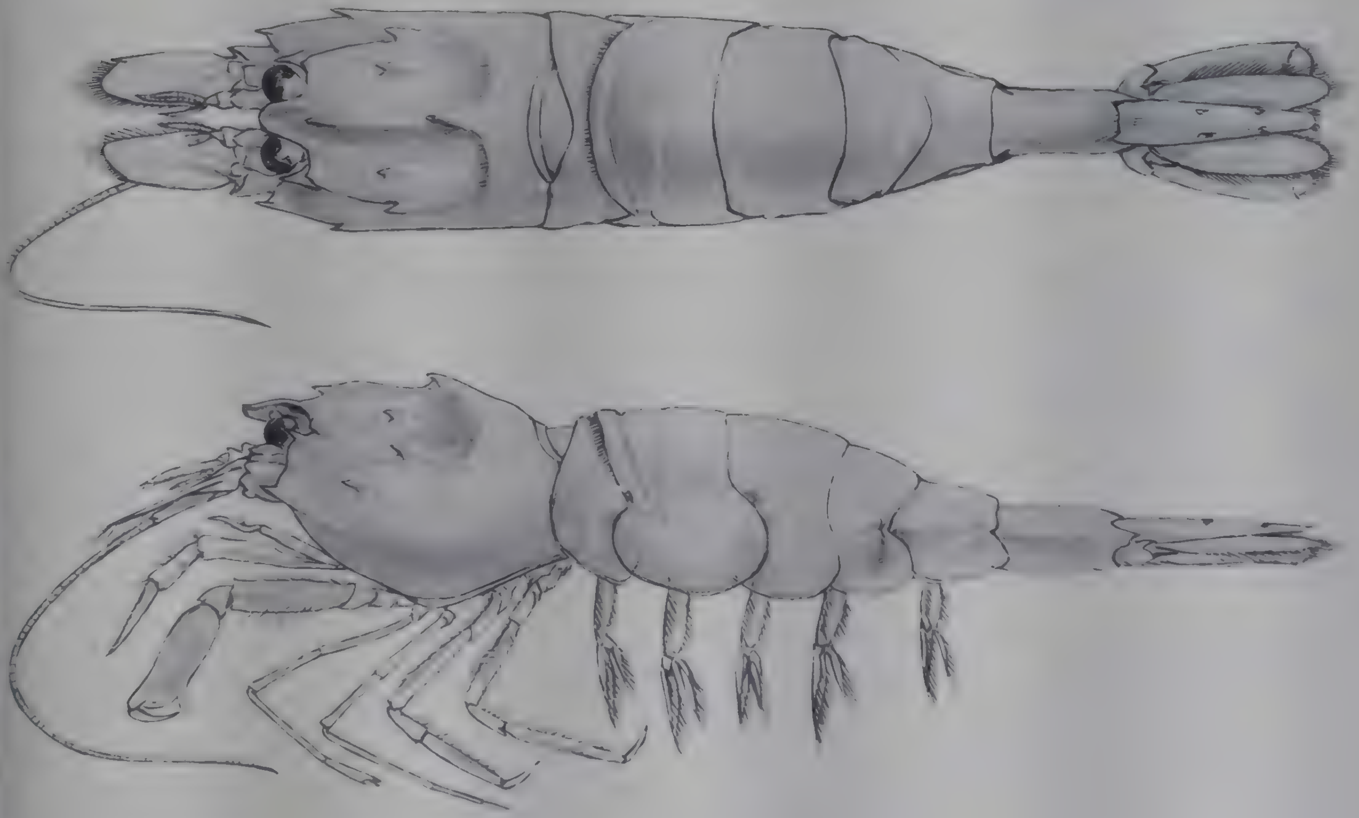
Key to species of genus *Mesocrangon*

1 Gastric region depressed below rest of carapace; lower submedian spine present
.... Miniature spinyhead, *M. munitella* (p. 121)

Gastric region not depressed below rest of carapace; lower submedian absent
.... Northern spinyhead, *M. intermedia* (p. 120)

MINIATURE SPINYHEAD

Mesocrangon munitella (Walker, 1898)



Description Body stout, depressed. Shell thick, surface somewhat rugose. Rostrum short, about 0.2 carapace length, wide, ventral blade, slightly descending, median sulcus, tip broadly rounded. Carapace spines: 2 median, anterior adjacent to base of rostrum, posterior about middle of carapace; carina between median spines; profile of dorsal margin slightly descending; submedian moderate, ahead of midcarapace, with supporting carina; lower submedian moderate, posterior to submedian, with supporting carina extending to posterior margin of depression; hepatic moderate, in anterior third of carapace, with short supporting carina; postorbital weak, carina from base to lower submedian; antennal moderate; branchiostegal strong, with supporting carina; pterygostomian very weak. Band around ventral margin of carapace widening to lobe adjacent to pereiopod II. Eye moderately large, cornea well developed, strong tubercle. Antennule: peduncle short, third segment subequal to second, first with dorsal, distal lobe; stylocerite short, broad, with small spine; inner flagellum shorter than outer, both shorter than antennal scale. Antenna: scale shorter than telson, lamella exceeding spine; basicerite, 3 lateral lobes; peduncle long, flagellum shorter than body. Third maxilliped: long, moderately stout; exopod long, with lash. Pereiopods: I longer than third maxilliped, very stout; propodus oblong, 2.4–3.2 average width, fixed finger long, stout; dactylus, when flexed, obliquely transverse; II longer than I, slender; chelate; III longer than II, as slender; dactylus slender, about 0.6 propodus length; IV shorter than III, stouter, setiferous; dactylus slender, about 0.5 propodus length; V longer than IV, as stout, setiferous; dactylus slightly flattened, about 0.35 propodus length. Abdomen: second somite with 2 dorsal transverse sulci; fourth with V-shaped lateral sulcus between articular knobs; on fifth, curved lateral carina between articular knobs, and anterior dorsal transverse sulcus; sixth with flat dorsal median carina, lateral carina extending from articular knob beyond middle of somite; telson moderately wide, tapering to rounded tip, 2 pairs dorsolateral spines; inner uropod longer than outer, and overreaching tip of telson.

Color In California (232) 1 specimen was mottled brown with bright markings along back; whole body of another was dark slate color; another was banded with slate color, with center of body red; still another had bands of slate and red alternating.

Distinctions Distinguished from other spinyheads by presence of a lower submedian spine on lateral surface of carapace; abrupt tapering of abdomen in fourth and fifth somites (in dorsal view); wide, T-shaped rostrum; short antennular flagella.

Maximum lengths Male: lengths unavailable; female: carapace 5.3 mm, total 23 mm.

Range Goose Island, Queen Charlotte Sound to Santa Catalina Island, CA (219); 2–73 m (232).

The first published record of the species in British Columbia waters was by Taylor (258), who collected a specimen near Goose Island, Queen Charlotte Sound, in 1906.

Biology and economics The miniature spinyhead apparently is not a common local species. Seven ovigerous females, 2.4–5.3 mm carapace length, were captured off Bunsby Island, 2–9 m, July 17, 1972. *M. munitella* was collected in San Francisco Bay at 6–13 m from a bottom of angular rock fragments, where it was associated with *Heptacarpus stimpsoni, Crangon nigricauda, C. franciscorum,* and 2 crab species; ranges of temperature and salinity were, respectively, 11.0–13.5°C and 26.6–31.6‰ (232). It is parasitized by the branchial isopod, *Argeia pugettensis* (100).

Family PANDALIDAE Haworth, 1825

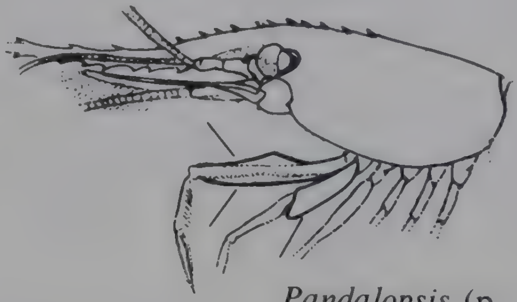
Rostrum generally conspicuous, laterally compressed, and armed with spines. Mandible with incisor process, without or with palp of two or three segments. Carapace with antennal spine, with either ptyergostomian or hepatic spines, without, but rarely with, supraorbital spine. Third maxilliped with or without exopod, and with epipod. First four pereiopods with or without epipods. First pereiopod slender, simple, or microscopically chelate. Second pereiopod slender, carpus with few or many segments; chelate. Outer margin of outer uropod, or exopod, with two distal spines, outer immovable, inner movable.

Members of the family are medium to large shrimps with a worldwide distribution. Most species occur on the continental shelf and slope but those of several genera inhabit abyssal depths (179, 229, 284). Eighteen genera are now recognized (131, 114, 292). In northern temperate seas species of at least two genera (*Pandalus, Pandalopsis*) support commercial fisheries (135, 171, 147). Another representative, *Heterocarpus reedi* Bahamonde, 1955, is fished off the coast of Chile (17). Literature pertaining to the family has been summarized (234).

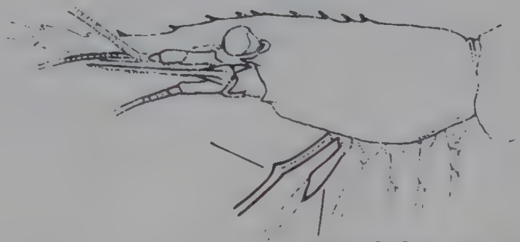
About 11 species, belonging to *Pandalus* and *Pandalopsis*, are among the relatively few animals that exhibit protandrous hermaphroditism (74, 268), i.e. each individual spends the early part of its life as a male and the later as a female. The larvae of many species in the family, i.e. "pandalids," are now known. There is considerable variation within the group, both in number of stages and in morphology; however, one consistent larval character is the absence in all stages of exopods on the fourth and fifth pereiopods (211).

Two genera are represented in British Columbia waters.

Key to genera of Family PANDALIDAE



1 Antennules twice length of carapace; antepenultimate segment of third maxilliped and ischium of first pereiopod each with a well-developed laminate expansion .... *Pandalopsis* (p. 123)



Antennules not 2 times longer than carapace; laminate expansions on antepenultimate segment of third maxilliped and ischium of first pereiopod little developed .... *Pandalus* (p. 126)

Genus *Pandalopsis* Bate 1888

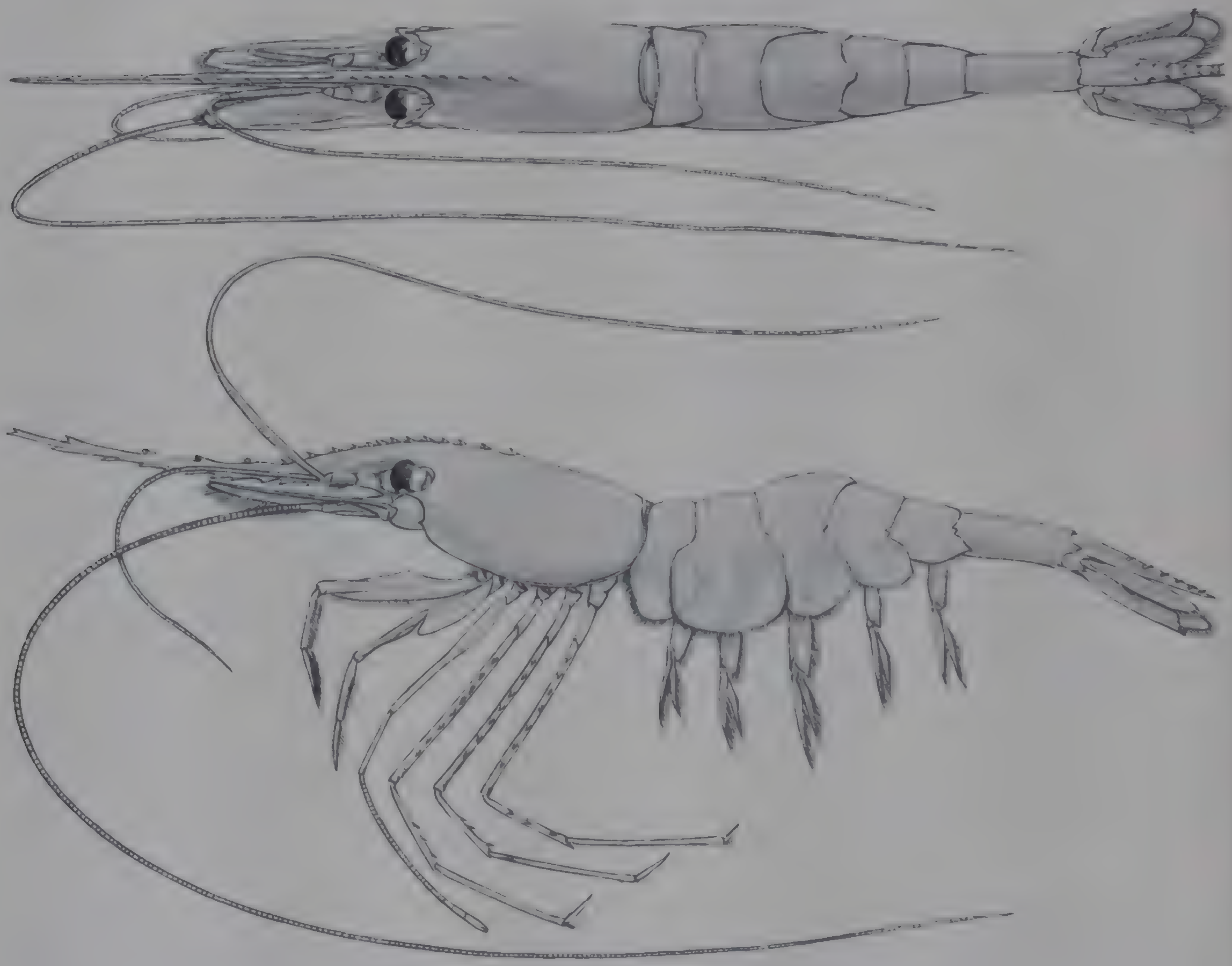
Rostrum long, conspicuous, with most dorsal spines movable. Antennal and pterygostomian spines present. Mandible with incisor process and palp of three segments. Antennules about twice length of carapace. Third maxilliped without exopod, with epipod, and with broad laminate expansion on antepenultimate segment. First four pereiopods with epipods. First pereiopod with broad laminate expansion on ischium. Second pereiopods equal or subequal in length, carpus of many segments, both chelate.

About nine species and a subspecies of *Pandalopsis* have been described (156). These shrimps are among the largest carideans. All occur in the North Pacific Ocean, but one species, *P. ampla* Bate, 1888, is also found in the South Atlantic Ocean, off Montevideo (26) and Patagonia (39). Members of the genus generally inhabit the deeper part of the continental shelf and the continental slope. At least two species distributed in Siberian waters are believed to be semibathypelagic (265). Vinogradov (266) coined a Russian term for species of the genus, "ravnolapye chilimy" or "equal-clawed" shrimps, referring to the second pereiopods.

One species, *P. dispar*, inhabits British Columbia waters. *P. ampla*, which occurs off Washington, may eventually be found. The latter is mainly distinguished by the absence of dorsal spines on the distal half of the rostrum. *P. ampla*, like *P. dispar*, is a protandrous hermaphrodite (39).

SIDESTRIPE SHRIMP

Pandalopsis dispar Rathbun, 1902



Other common name: giant red

Description Body moderately stout, compressed. Shell thin, surface finely pitted. Rostrum long to very long, 1.6–2.8 carapace length, arched over eyes, distal two-thirds ascending slightly, $\frac{16\ 21}{9\ 15}$, dorsal movable except 2 and 3 most distal, tip bifid, or trifid. Carapace spines: antennal strong, with slight supporting carina; pterygostomian moderate to weak. Eye large, cornea well developed. Antennule: peduncle short, third segment about half length of second; stylocerite short, flat lobe; outer flagellum longer than body, with flattened proximal part, inner about half length of outer. Antenna: scale longer than telson, narrow, lamella exceeds spine; basicerite, 2 lateral lobes; peduncle moderately long; flagellum about 1.5 body length. Third maxilliped: moderately long, 2 distal segments slender, antepenultimate proximal with broad lamina; epipod. Pereiopods: I shorter than third maxilliped, slightly stouter, setiferous; ischium with broad lamina; merus, proximal end slightly flattened; carpus, inner distal surface recessed, bordered by setae; propodus, inner proximal surface with about 25 oblique rows of setae; dactylus short, slender, rounded tip; epipod; II longer than I, both sides equal, mainly very slender; ischium, proximal end flattened; carpus, 26–33 segments; chelate; epipod; III longer than II, stouter; ischium, 0 or 1 spine; merus, 7–9 and 3–5 spines; carpus, 2 or 3 spines; propodus, 7–9 tufts of spinules and setae, evenly spaced; dactylus slender, about 0.33 propodus length, 5 minute proximal spines; epipod; IV slightly shorter than III, as slender; ischium; 0 or 1 spine; merus, 8 or 9 and 1–3 spines; carpus, 1–3 spines; propodus, as in III; dactylus slender, about 0.3 propodus length, 4 minute proximal spines; epipod; V shorter than IV, as slender; merus, 8 or 9 and 1–3 spines; carpus, 1–3 spines; propodus, as in III; dactylus about 0.15 propodus length, 5 minute proximal spines. Abdomen: dorsal posterior margin of third somite projected moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; weak ventral spine on pleuron of fourth; fifth with strong posterolateral spine; sixth elongate, with weak posteroventral lobe; telson narrow, tapering markedly to acute tip, 5–7 pairs dorsolateral spines; outer uropod reaching or exceeding telson, inner considerably shorter.

Color Reddish orange over most of body and appendages; rows of broken longitudinal white bars on dorsal and lateral surfaces of first to sixth abdominal somites; irregular white patches and bars on posterior half of carapace; meri of pereiopods III–V deeper red than carapace, with white bars; ischia of these pereiopods with white patches (Plate 8D).

Distinctions Known by the antennules, both more than twice as long as carapace; broad laminate expansions on antepenultimate segment of third maxilliped and ischium of pereiopod I; unequal propodi, increasing in length from pereiopod III to V, and dactyli of some pereiopods decreasing posteriorly; inner uropods considerably shorter than outer pair; in freshly caught specimens, white bars on the abdomen. Dorsal spines distributed along entire length of rostrum distinguishes this species from *P. ampla.*

Maximum lengths Males: carapace 31.0 mm; total 182 mm; females: carapace 36.3 mm, total 208 mm.

Range Pribilof Islands, Bering Sea (219), to Manhattan Beach, OR (227); 46–649 m (219).

First taken on the west coast of Canada by the *Albatross* in Queen Charlotte Sound at 436 m, Aug. 29, 1888 (station 2862) (219).

Biology and economics Growth and reproduction in southern waters of the province are known (31, 57). Eggs carried on females hatch during March and April, and the pelagic life of 5 or 6 stages begins (31). Metamorphosis appears to occur in late July or August on the same grounds inhabited by older age groups. Males mature first in the second autumn about 18 mo after hatching, at carapace length of 21.6 mm and weight of 6.5 g. Sex change begins the next spring when individuals are reaching 2 yr of age, and most of the summer is required for completion of the 4 or 5 transition stages. By late October in the third autumn, the shrimps, then females 29.3 mm and about 16 g, breed and extrude eggs. The normal incubation period is about 5½ mo. Hatching begins in March and in most cases is completed before the end of April, when females are about 36 mo old. Subsequently, numbers of these females diminish and relatively few appear to survive into the fourth year.

In the Strait of Georgia, the mean egg count for 44 females 24.8–32.7 mm was 1129. The average estimate of egg numbers, obtained by partial counts for 25 ovigerous females from Alaska waters, was 4150 (137); and in Puget Sound, the mean estimate was 903 eggs, obtained from 244 females (108).

The sidestripe shrimp is infested by the branchial isopod, *Bopyroides hippolytes* (225). Incidence of the bopyroid in 3 local populations was 1.4–2.3%; the parasite retarded growth and appeared to delay sex change in the shrimps (J. C. Scrivener unpublished data).

Commercial quantities of *P. dispar* are taken by trawling at 73 m and deeper in Chatham Sound, Stuart Channel, and Barkley Sound, but landings of the species are included in a mixed shrimp category in statistical records provided by the Department of Fisheries and Oceans. This shrimp is rarely, if ever, caught in baited traps.

Genus *Pandalus* Leach, 1814

Rostrum long, conspicuous, with most dorsal spines movable. Antennal and pterygostomian spines present. Mandible with incisor process and palp of three segments. Antennules shorter than carapace on some species, longer on others, but not exceeding body length. Third maxilliped without exopod, with epipod; laminate expansion on antepenultimate segment, if present, only slight. First pereiopod has slight laminate expansion on ischium, if at all; tip simple, or with terminal pegs formed by finger of propodus and dactylus. Second pereiopods unequal: right normally shorter, stouter, and carpus with about a third as many segments as left, both chelate.

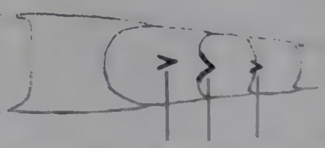
Members of the genus are medium to large shrimps. About 17 species and subspecies are found at all depths on the continental shelf and slope mainly in the northern hemisphere (179). Seven species, *P. borealis, P. goniurus, P. hypsinotus, P. jordani, P. montagui, P. platyceros, P. prensor,* are said to have economic value (135). At present the two most important species on the British Columbia coast are *P. jordani* and *P. platyceros.*

Eight species occur on the British Columbia coast.

Key to species of genus Pandalus

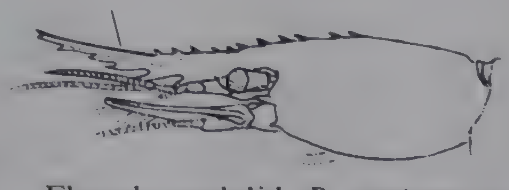
1 Third somite of abdomen in part compressed and carinated, carina forms a more or less well-defined lobe or spine in front of posterior margin 2

Third somite of abdomen not compressed or carinated 4

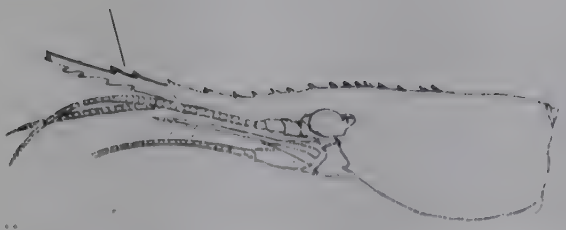


2 Third and fourth somites of abdomen each armed with median spine on posterior margin .... Pink shrimp, *P. borealis* (p. 128)

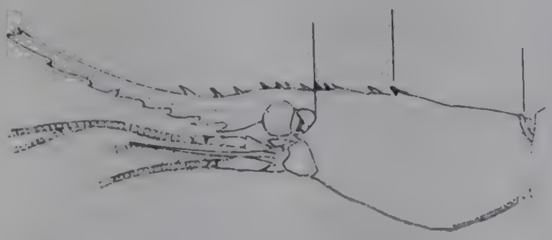
Third and fourth somites without median spines 3



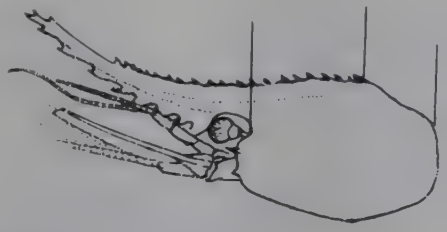
3 Rostrum unarmed on distal half of dorsal margin .... Flexed pandalid, *P. goniurus* (p. 131)



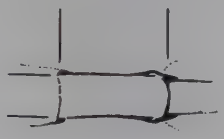
Rostrum with spines on distal half .... Smooth pink shrimp, *P. jordani* (p. 133)



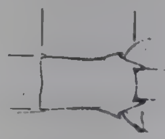
4 Dorsal spines absent behind middle of carapace 5



Dorsal spines present behind middle of carapace 6



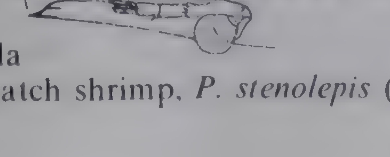
5 Sixth abdominal somite more than twice as long as wide .... Yellow-leg pandalid, *P. tridens* (p. 136)



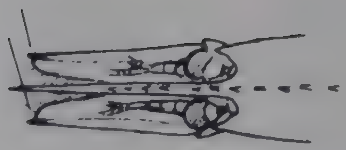
Sixth abdominal somite less than twice as long as wide............... .... Prawn, *P. platyceros* (p. 139)

6 Dorsal spines 17–21 .... Humpback shrimp, *P. hypsinotus* (p. 143)

Dorsal spines 8–12 7



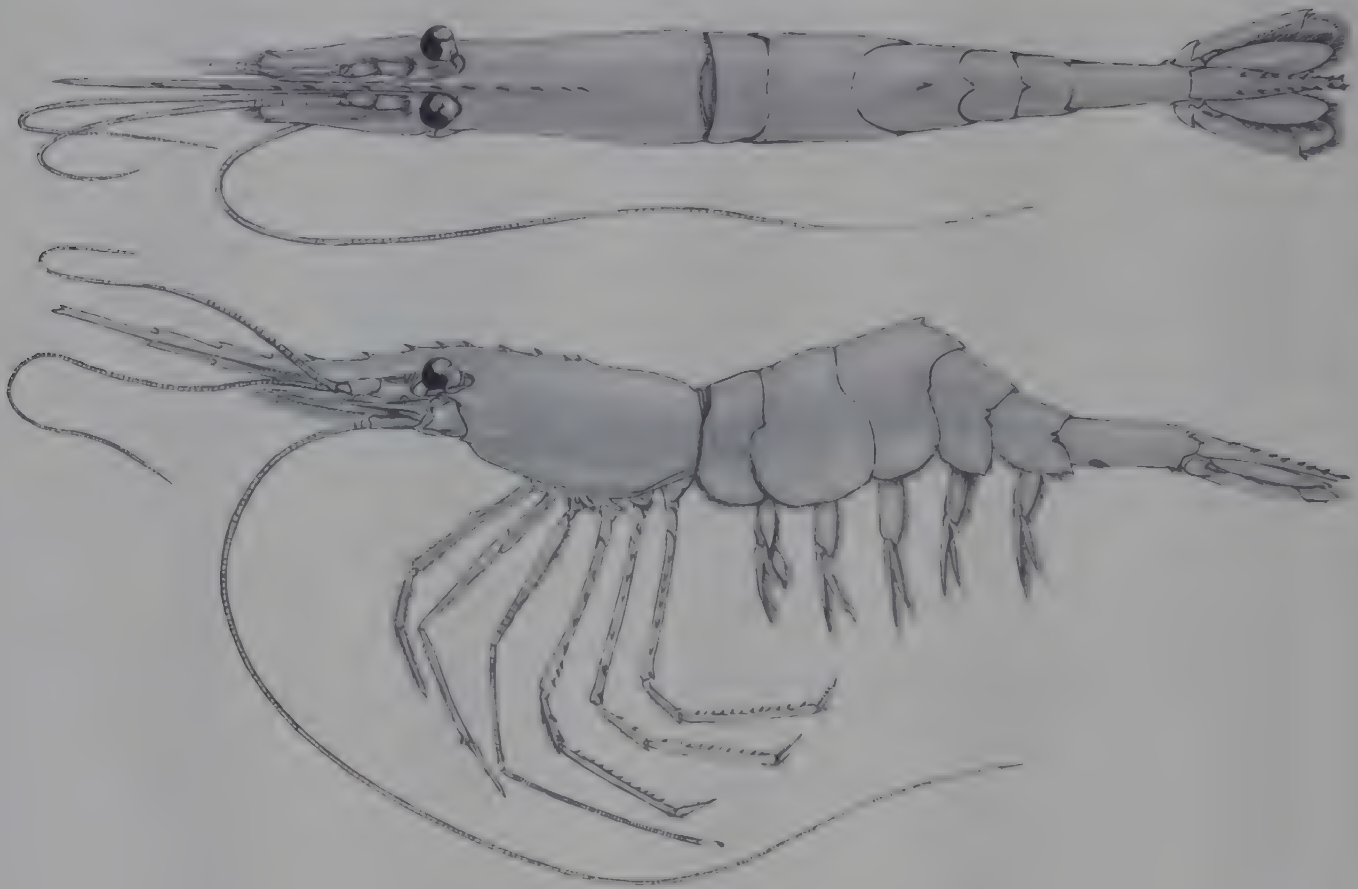
7 Antennal scale very narrow, distal half of lamella narrower than spine .... Rough patch shrimp, *P. stenolepis* (p. 145)



Antennal scale of moderate width, distal half of lamella wider than spine .... Coonstripe shrimp, *P. danae* (p. 147)

PINK SHRIMP

Pandalus borealis Krøyer, 1838



Other common names: northern shrimp, deepsea prawn, crevette nordique, hokkoku aka ebi (Japan), severnyi shrims (USSR)

Description Body slender, compressed. Shell thin, surface smooth. Rostrum long, 1.5-2.1 carapace length, arched over eyes, distal half ascending, $\frac{12\text{-}16}{6\text{-}9}$, dorsal spines, except 1-3 distal, movable, tip bifid. Carapace spines: antennal strong, with supporting carina; pterygostomian weak. Eye large, cornea well developed. Antennule: peduncle moderately long, second segment about twice length of third; stylocerite short, rounded lobe; both flagella somewhat longer than carapace, inner longer. Antenna: scale longer than telson, moderately broad, lamella exceeds spine slightly; basicerite, upper lateral lobe, lower strong spine; peduncle short; flagellum about body length. Third maxilliped: long, moderately stout; antepenultimate segment with slight lamina; epipod. Pereiopods: I longer than third maxilliped, as stout; ischium with slight lamina; proximal part of merus flattened; distal inside surface of carpus with recess bordered by long setae, adjacent distally a pronounced knob; short terminal pegs; epipod; II chelate; epipod, left longer and more slender; ischium with proximal part flattened, and about 5 faint distal annulations; merus, most of length with annulations; carpus about 58 segments; right ischium and merus, with no apparent annulations; carpus, 25–27 segments; III longer than both sides of II, stouter; ischium, 0 or 1 spine; merus, 6 or 7 and 5 spines; carpus, 2 or 3 spines; propodus, 16–18 spinules, 2 rows; dactylus slender, about 0.34 propodus length, 6 or 7 spines, epipod; IV about as long as III, as slender; ischium, 0 or 1 spine; merus, 6–8 and 3–5 spines; carpus, 2 or 3 spines; propodus, 20–22 spinules, 2 rows; dactylus slender, about 0.3 propodus length, 5 or 6 spines; epipod; V shorter than IV, as slender; ischium, 0 or 1 spine; merus, 6–9 and 1 spine; carpus, 1 or 2 spines; propodus, 20–22 spinules, 2 rows; dactylus slender, about 0.28 propodus length, 5 or 6 spines. Abdomen: third somite with dorsal posterior part compressed and carinated, produced posteriorly as strong median spine or lobe, posterior margin produced as acute lobe with small terminal spine; fourth with strong median posterior spine, pleuron with moderate to weak ventral spine; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with weak posterolateral spine; sixth shorter than telson, with weak posteroventral spine; telson narrow, tapering to blunt tip, 6–10 pairs dorsolateral spines; inner uropod slightly shorter than outer, both normally shorter than telson.

Color Fine red dots over entire animal, with translucent background. Darker red due to concentration of red dots on dorsal surface and along ventral margin of carapace, distal part of rostrum, basicerite and peduncle of antenna, antennular peduncle and flagella, dorsal surface of abdomen especially third to sixth somites, proximal part of telson, and uropods. Fifth pereiopod more or less uniformly dark red; red dots sparse on proximal segments of other pereiopods; propodi and dactyli of third and fourth pereiopods dark red (Plate 2E).

Distinctions Distinguished by presence of prominent median dorsal spines on third abdominal somite, posterior margin and another at bend of abdomen, median posterior spine on fourth abdominal somite; dorsal spines on distal half of rostrum; in freshly caught specimens, fairly uniform pink to bright red coloration.

Maximum lengths Males: carapace 20.4 mm, total about 121 mm; females: carapace 26.1 mm, total about 150 mm.

Range Chukchi Sea, Point Barrow (175); Bering Sea, Cape Navarin (265), St. Matthew Island to Columbia River mouth (219); Okhotsk Sea (265); Sea of Japan, Hokkaido, Toyama Bay (297), Vladivostok (265), Korea; Barents Sea to North Sea (5); western Greenland to Gulf of Maine (121); 16–1380 m (265).

First taken in British Columbia waters by *Albatross* west of Race Rocks at 183 m, Aug. 27, 1891 (station 3445) (219).

Biology and economics In southern British Columbia the main features of growth and reproduction have been studied (31, 57). Hatching of larvae occurs in March and April, and there is a pelagic life of 5 or 6 stages (31). Almost as many females as males mature at about 18 mo, around a carapace length of 16.1 mm and weight of about 3 g. Females of this age group breed in mid-November and are ovigerous throughout the winter. The males begin sex change in spring when about 2 yr old, undergoing about 4 or 5 transitional molts during the summer. At about 30 mo all individuals are females, average 20.6 mm, and weigh about 6 g. Most are ovigerous during the following winter, some for the first time, the rest for the second time. At the end of hatching late in the spring, females have reached their third birthday. Relatively few appear to survive into the fourth year.

Studies off Norway (215) and in the North Sea (5) revealed essentially the same cycle for the species; in the latter area the normal life span was 3 yr. The growth rate is slower, the life span longer, age at sex changes later, and the ovigerous period longer in high latitudes and at colder ambient temperatures (121). The mean count of eggs from 42 females 15.2-23.9 mm carapace length, caught in Burrard Inlet, was 1631. In Alaskan waters, the mean estimate of eggs on 25 females based on partial counts was 2150 (137). Counts were made in several Atlantic regions (215, 5, 121). An early description of the first stage larva was based on a laboratory rearing (31). Later stages to the seventh were obtained from plankton samples (163). The larval series of *P. borealis* to stage VIII was reared in Kachemak Bay, AK (119).

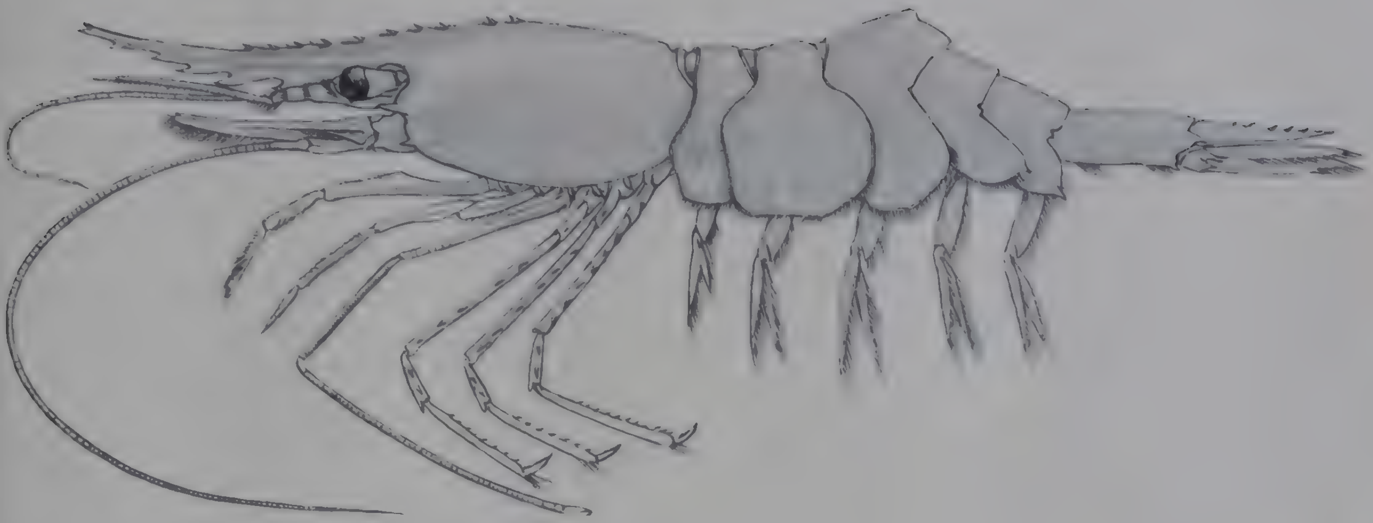
Circumstantial evidence from Alaska is that pink shrimps migrate vertically, leaving the vicinity of the bottom about dusk, and returning about dawn (23). In Burrard Inlet, food consisted mainly of mysids (*Neomysis franciscorum* Holmes, 1900), and other unidentified crustaceans (A.B. Needler unpublished data). In its habitat, *P. borealis* is eaten by large fish such as dogfish, Pacific cod, turbot, and hake. Parasites of the pink shrimp in the Pacific Ocean are the bopyrid isopid, *Bopyroides hippolytes* (225), and the rhizocephalan, *Sylon hippolytes; Hemiarthrus abdominalis* infests Atlantic populations (269).

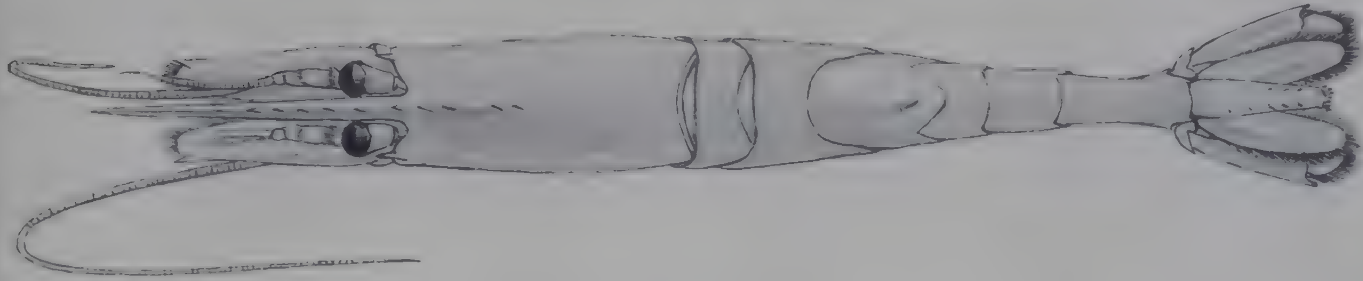
Along the British Columbia coast the species is limited in distribution mainly to mainland inlets, probably due to lower prevailing water temperatures. It occurred in Burrard Inlet within the temperature and salinity ranges, 7.37-11.08°C and 25.88-30.84‰, respectively (57). Largest trawl catches are made locally on a soft mud bottom at 54-90 m. No separate records of landings are available but, in the present writer's opinion, the pink shrimp now ranks next to the smooth pink and the prawn in the British Columbia shrimp industry. Following World War II, it was the leading species until the mid-1950s when production of *P. jordani* from Vancouver Island grounds became more important. The pink shrimp is still fished in English Bay by one-man beam trawlers as it was over 30 yr ago.

For further information on the biology of the species and fisheries elsewhere see (234, 60, 122, 136, 229, 73, 140, 142, 144, 215, 146).

FLEXED PANDALID

Pandalus goniurus Stimpson, 1860





Other common names: humpy, beni suji ebi (Japan)

Description Body slender, compressed. Shell thin, surface smooth. Rostrum moderately long, 1.0–1.5 carapace length, distal half ascending, $\frac{8\text{-}10}{6\text{-}7}$, dorsal spines movable, rostral distal half lacks spines, tip bifid. Carapace spines: suborbital rounded; antennal rounded; pterygostomian strong. Eye moderately large, cornea well developed. Antennule: peduncle moderately long, third segment shorter than second; all segments with distal setae; stylocerite short, distal end rounded; inner flagellum slightly longer than total rostrum length, outer over half as long. Antenna: scale longer than telson, moderately wide, spine exceeds lamella slightly; basicerite, upper lateral lobe, lower strong spine; peduncle short; flagellum longer than body. Third maxilliped: moderately long, moderately stout; antepenultimate segment with slight lamina; epipod. Pereiopods: I about as long as third maxilliped; more slender; ischium with slight lamina; merus, proximal half flattened; carpus and propodus as in *P. borealis;* short terminal pegs; epipod; II chelate; epipod; left longer and more slender; ischium, proximal half flattened, and 6 or 7 faint distal annulations; merus, annulations most of length; carpus, 51–54 segments; right ischium and merus, with no apparent annulations; carpus, 18–20 segments; III shorter than left longer than right of II, stouter; ischium, 0 or 1 spine; merus, 5 or 6 and 4 or 5 spines; carpus, 2 and 1 spines; propodus, 14–16 spinules, 2 rows; dactylus slender, about 0.3 propodus length, 5-8 spines; epipod; IV slightly shorter than III, as slender; ischium, 0 or 1 spine; merus 4-7 and 4-6 spines, carpus, 2 spines; propodus, 10–13 spinules, 2 rows; dactylus slender, about 0.28 propodus length, 8 spines; epipod; V slightly shorter than IV, as slender; ischium, 0 or 1 spine; merus, 6 and 2 spines; carpus, 2 spines; propodus, 15–18 spinules, 2 rows; dactylus slender, about

0.2 propodus length, 7 or 8 spines. Abdomen: anterior lateral margin of pleuron of first somite straight or slightly convex; anterior lateral margin, and part of ventral margin of second straight or slightly convex; third with dorsal posterior part strongly compressed, extended posteriorly as median lobe; posterolateral margins of fourth and fifth widely recessed at articular knobs; fourth with moderate ventral spine on ventral margin of pleuron; strong posterolateral spine on fifth; sixth about as long as telson, with moderate posteroventral spine; telson moderately wide, tapering to blunt tip, 5–7 lateral spines; uropods about equal, and exceed telson.

Color Background transparent to whitish; striping of red to orange dots on sixth abdominal somite dorsally and laterally, latter extending forward across lower parts of pleura of third to fifth somites; other oblique striping from dorsal surfaces of third to fifth somites extending to second pleuron; another stripe borders anterior margin of first somite. On carapace, red dots form oval outline on dorsal and lateral surfaces, dots of outline meet ventral margin adjacent to bases of all pereiopods, also along frontal margin from antennal spine to above orbit, along gastric region confluent with band of dots below 6 posterior dorsal spines on rostrum and carapace; another band extends along lower limb of rostrum from near base to tip; yellow patches on lateral surface. Groups of red dots on protopodites of pleopods; also scattered on telson and uropods, with large yellow spots on proximal parts of these appendages; yellow spots on each segment of third maxilliped, with red spots on distal segment; all pereiopods except II have red spots, with yellow spots on ischium of pereiopod I; also red banding on outer antennular flagellum; outer margin of antennal scale and basicerite marked with red (Plate 7E).

Distinctions Separated from its congeners, also with slender bodies and thin shells, by median dorsal lobe as if "pinched" on third abdominal somite; absence of median spine on dorsal posterior margin of fourth somite; moderately long, slightly ascending rostrum that lacks dorsal spines on distal half. Distinctive striping on abdomen persists for some time in formalin.

Maximum lengths Males: carapace 13.1 mm, total about 62 mm; females: carapace 16.5 mm, total about 78 mm.

Range Chukchi Sea (195, 221); Bering Sea, to Puget Sound (219); Okhotsk Sea; Sea of Japan, to near Vladivostok; 5–450 m (265).

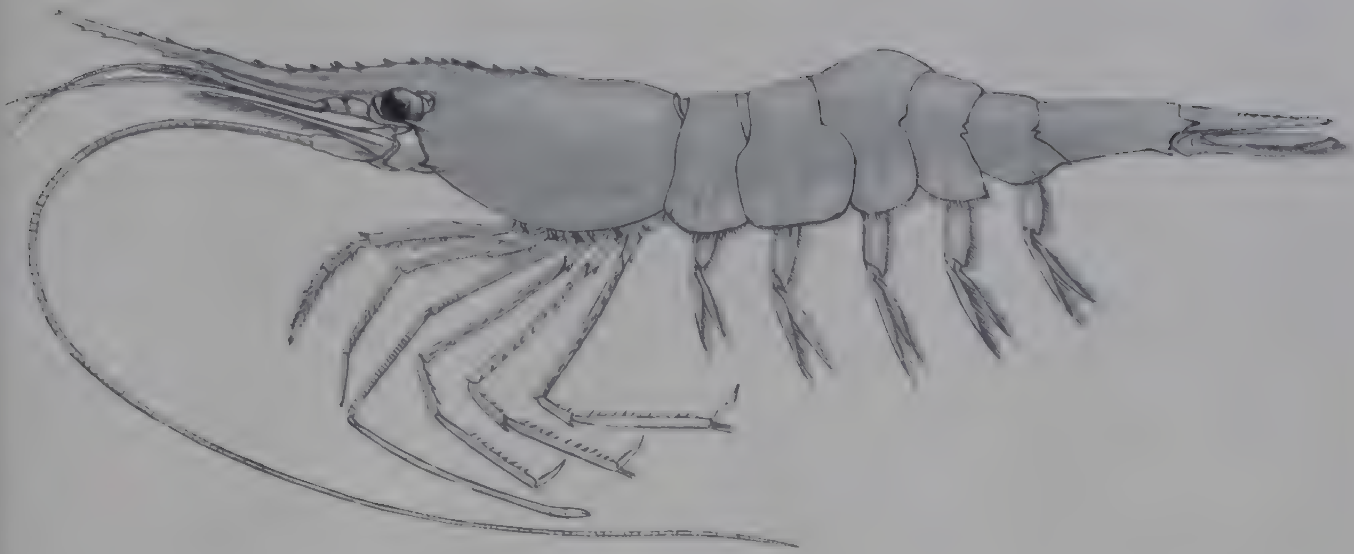
First taken in British Columbia waters by *Albatross* west of Jordan River at 97 m, Sept. 2, 1891 (station 3460) (219).

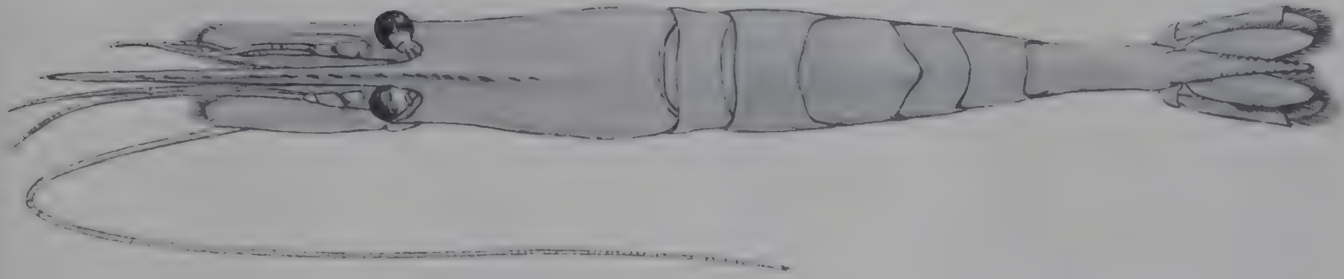
Biology and economics The species is a protandrous hermaphrodite (57). The indication from fragmentary data is that it matures as a male in its first year and then changes sex in the second summer; following the hatching of eggs at 2 yr most females appear to die. The ovigerous period is from late November to April (57). The average estimate of egg numbers, obtained by partial counts from ovigerous females in Alaska waters, was 2000 (137). The first stage larva, taken from an ovigerous female, was described fully (141), and there are partial descriptions of 6 later stages from plankton collections (176). Finally, the complete series of stages has been reared at Kachemak Bay, AK, and described fully (117). A predator is the sand sole (189). *P. goniurus* was caught by trawling and dredging in the eastern Bering Sea on mud to coarse sand bottom, 38–124 m, at -0.3° to 6.4°C (187).

The species constitutes a recognized, though small, part of shrimp landings in several Alaska areas (137, 22), but in local waters the number now occurring in trawl catches is negligible. Early in 1949 a fishery in Clio Channel, near the northeastern coast of Vancouver Island, produced this shrimp along with the main commercial species, *P. hypsinotus* (57). Reportedly, it was fished near Lopez Island, WA, in the 1930s (240).

SMOOTH PINK SHRIMP

Pandalus jordani Rathbun, 1902





Other common names: ocean shrimp, ocean pink shrimp

Description Body slender, compressed. Shell thin, surface smooth. Rostrum long, $\frac{4\ \ 17}{6\ \ 8}$, carapace length, distal half slightly ascending, $\frac{14\ \ 17}{7\text{-}10}$, dorsal spines, except distal 2 or 3, movable, tip acute or bifid. Carapace spines: suborbital angle slightly convex; antennal strong; pterygostomian moderate. Eye large, cornea well developed. Antennule: peduncle moderately long, third segment shorter than second; stylocerite short, distally as rounded lobe; both flagella longer than carapace, outer a little longer. Antenna: scale longer than telson, moderately wide, tips of lamella and spine in line; basicerite, moderate upper lateral spine, strong lower spine; peduncle short; flagellum longer than body. Third maxilliped: moderately long, moderately stout; antepenultimate segment with slight lamina; epipod. Pereiopods: I longer than third maxilliped, more slender; ischium with slight lamina; proximal end of merus with lamina; carpus and propodus as in *P. borealis;* short terminal pegs; epipod; II chelate; epipod; left longer and more slender; ischium, proximal third with lamina, 6 or 7 faint distal annulations; merus, annulations almost entire length, carpus, 58-62 segments; right ischium and merus with no apparent annulations; carpus, 19-22 segments; III longer than right, shorter than left of II, stouter; ischium, 1 spine; merus, 7-10 and 4-7 spines; carpus, 2 or 3 spines; propodus, 13-19 spinules, 2 rows; dactylus slender, about 0.36 propodus length, 5-7 spines; epipod; IV shorter than III, as slender; ischium, 1 spine; merus, 7-11 and 1-5 spines; carpus 2 or 3 spines; propodus, 15-22 spinules, 2 rows; dactylus slender, about 0.35 propodus length, 5 or 6 spines; epipod; V about as long as IV, as slender; ischium, 0 or 1 spine; merus, 9 or 10 and 1 spine; carpus, 1 or 2 spines; propodus, 12–23 spinules, 2 rows; dactylus slender, about 0.4 propodus length, 4 or 5 spines. Abdomen: ventral margins of pleura of first to third somites mainly straight or slightly concave; third somite with dorsal posterior part compressed and carinated, with median lobe of varying size; posterolateral margins of third to fifth widely recessed at articular knobs; pleuron of fourth with moderate ventral spine; fifth with strong posterolateral spine; sixth shorter than telson, with weak posteroventral spine; telson narrow, tapering to acute tip; 8–13 pairs dorsolateral spines; inner uropod slightly shorter than outer, both exceed telson.

Color Surface of shrimp almost entirely covered by fine red dots. These are distributed more densely on telson, posteroventral angle of sixth somite, branchial region of carapace, and distal ventral margin of rostrum, giving a darker red. Proximal part of antennal flagellum pale pink. Specimen illustrated (Plate 4D) showed more color on proximal segments of pereiopods than normal for species, at least in British Columbia waters.

Distinctions Separated from *P. borealis,* which is very similar in morphology, by absence of a median dorsal spine on posterior margin of fourth abdominal somite; antennular flagella shorter than total length of rostrum.

Maximum lengths Males: carapace 21.0 mm, total 125 mm; females: carapace 29.3 mm, total 175 mm.

Range Iliuliuk Harbor, Unalaska Island (219) to San Nicholas Island, CA, 36–457 m (232, 81).

The first recorded capture in Canadian waters was by the *Albatross* off Port San Juan at 212 m, Aug. 28, 1891 (station 3447) (219).

Biology and economics The life cycle of *P. jordani* is known for southern British Columbia (57). Larvae hatch from late March to early April and, following an unknown larval life, metamorphosis to the adult form occurs in August. Normally individuals reach maturity first as males at 1½ yr, when 17.6 mm in carapace length and weighing almost 4 g. In some years, up to 40% of an age group may mature first as females. Sex change of 2-yr-old males, at about 17.9 mm carapace length and 4 g body weight, is already in progress by early April and continues through the third summer. They are normally mature females by the autumn (20.2 mm carapace length and almost 6 g). Females carry eggs, starting in late November, for about 4½ mo. Following hatching in the spring, some females appear to live into the fourth year but most die.

Growth and reproduction are similar in populations elsewhere in British Columbia, and from Washington to California (259, 81). Forty-nine females from the Strait of Georgia, 18.5–27.1 mm carapace length, had a mean egg count of 2506 eggs, comparing fairly well with the fecundity of females off California (81). There is a description of eggs at different stages of embryonic development (81). Larval stages are known (194, 165) and larval ecology was studied (230).

The species is usually found on a green mud or mixed sand and mud bottom (81). Temperature and salinity ranges for the shrimp in the Strait of Georgia were 7.44–10.97°C and 28.69–30.83‰, respectively (57). On California shrimp grounds, bottom temperatures 7.1–11.5°C, and salinities 33.04–34.64‰, were recorded (81). Reportedly, off Oregon, smooth pink shrimps, especially young individuals, migrate vertically at night, and while off the bottom eat euphausiids and copepods (204). On bright sunny days, shrimps rest on the bottom but, during cloudy overcast days they may swim up to 2.5 m off the bottom (27). Off northern California, shrimp stomachs contain polychaete worms, sponge, diatoms, and appendages of amphipods and isopods (81). Reported predators are hake and turbot (102) and dogfish, lingcod, Pacific cod, and skates can be added. In Canadian waters, *P. jordani* is infested (225) by the branchial isopod, *Bopyroides hippolytes* (Fig. 3A). Incidence of this parasite in 6 local populations was 0.30–0.57%; infestations retarded growth of and accelerated sex change in host shrimps (J. C. Scrivener unpublished data). The rhizocephalan, *Sylon hippolytes,* mainly occurs on *P. jordani* in Queen Charlotte Sound and other northern areas. A microsporidian, *Thelohania* sp. (264), was in 0.73% of specimens sampled off Tofino in May 1973.

Biometricians have been particularly active in research on the dynamics of *P. jordani* populations (2, 103, 104, 98, 74, 93).

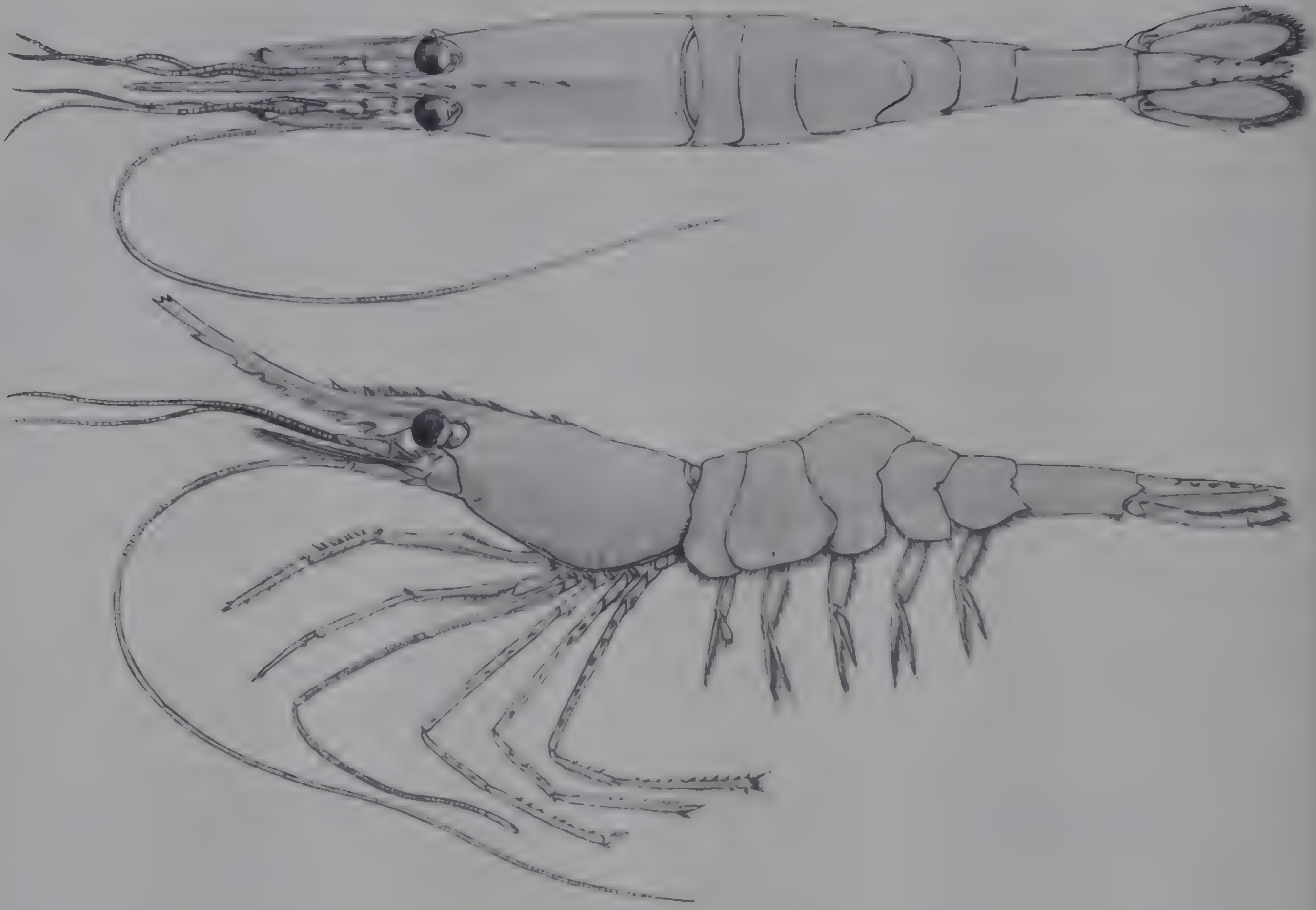
Fishable populations are known from Queen Charlotte Sound to northern California (64, 229), but the region of greatest abundance is located off central Oregon (81). The first fishery for the smooth pink shrimp on the British Columbia coast was in Stuart Channel in 1952 (51). Since 1960 it has been the most important commercial species. As a result of exploratory surveys by the Pacific Biological Station in Nanaimo (62, 63, 64), there are now other shrimping operations for *P. jordani,* either regular or sporadic, off Comox, near Calvert Island, in Barkley Sound, and on the continental shelf off Tofino and Nootka Sound. Landings (in metric tons) from the 2 latter grounds, accounting for most of the province's shrimp production in recent years were:

	Tofino Ground			
	Canada	U.S.	Total	Nootka Ground
1973	359	–	359	–
1974	810	612	1422	–
1975	561	119	680	–
1976	3448	1564	5012	40
1977	2421	2	2423	107

The Nootka ground is not fished by U.S. vessels because it lies within Canada's 12-mile exclusive fishing zone. In 1978, 22 Canadian vessels operated on these grounds. The fluctuations in landings shown above are related directly to variations in fishing effort and changing recruitment (J. A. Boutillier unpublished data). Since 1977 the Tofino fishery has been managed under Canada's Extension of Fisheries Jurisdiction by limited entry and quota, or total allowable catch (TAC). For further information on *P. jordani* see (234, 81, 229, 230, 73).

YELLOW-LEG PANDALID

Pandalus tridens Rathbun, 1902



Description Body moderately stout, little compressed. Shell thin, surface smooth. Rostrum moderately long, 1.3–1.8 carapace length, distal half ascending slightly, $\frac{9-13}{6-8}$, all dorsal spines movable, not extending to distal half, tip trifid, rarely bifid. Carapace spines: antennal strong; pterygostomian moderate. Eye large, cornea well developed. Antennule: peduncle moderately long, third segment subequal to second, distal margin of both with dorsal distal setae; stylocerite short, distally rounded lobe; flagella about equal, extend beyond rostrum by about a third their lengths. Antenna: scale longer than telson, narrow, spine exceeds lamella slightly; basicerite, small upper lateral lobe, lower weak spine; peduncle moderately long; flagellum longer than body. Third maxilliped: long, moderately stout; antepenultimate segment with slight lamina; merus, proximal half flattened with lamina; carpus and propodus as in *P. borealis*, short terminal pegs; epipod; II chelate; epipod; left longer and more slender; ischium, proximal third with lamina, 8 or 9 faint distal annulations; merus, entire length with annulations; carpus, about 74 segments; right ischium and merus with no apparent annulations; carpus, 20–28 segments; III shorter than left, longer than right of II, stouter; ischium, 0 or 1 spine; merus, 6 or 7 and 4 or 5 spines; carpus, 3 or 4 spines; 17-28 spinules, 2 rows (including 2 distal groups of 3); dactylus moderately stout, about 0.2 propodus length, 5–8 spines; epipod; IV slightly shorter than III, as slender; ischium, 1 spine; merus 6 or 7 and 4 or 5 spines; carpus, 2 or 3 spines; propodus 17-32 spinules, 2 rows (including 2 distal groups of 3); dactylus moderately stout, about 0.2 propodus length, 5–8 spines; epipod; V about as long as IV, as slender; ischium, 0 or 1 spine; merus, 6–8 and 1 or 2 (at distal end) spines; carpus, 2–4 spines; propodus, 15–26 spinules, 2 rows; dactylus moderately stout, about 0.15 propodus length, 5–7 spines. Abdomen: ventral margin of pleuron of first somite straight or slightly concave; dorsal posterior margin of third with moderate projection; posterolateral margins of third, fourth, and fifth somites widely recessed at articular knobs; pleuron of fourth with weak to moderate ventral spine; posterolateral margin of fifth with strong spine; sixth shorter than telson, with moderate posteroventral spine and lobe above, slightly flared; telson moderately wide, tapering to blunt tip; 5 pairs of lateral spines; inner uropod slightly shorter than outer, both exceed telson.

Remarks In an early paper, Rathbun (216) referred specimens caught in the Bering Sea to *Pandalus montagui* Leach, a species inhabiting the North Atlantic Ocean, but in 1902 (217) she assigned the North Pacific population to a separate subspecies, *P. montagui tridens*. The distinguishing characters are discussed below. In 1965, Squires (247) described the coloration of western Atlantic specimens of *P. montagui* as, "conspicuously marked with dark pink oblique stripes on a light pink background," and went on to suggest that a new species name was appropriate for *P. montagui tridens* on account of its different coloration (57). Nothing further appeared on the subject until 1971 when Ivanov described the first stage larva of *P. montagui tridens* (145). This larva (in having a pterygostomian spine, many small spines on the anterolateral and posterolateral margins of the carapace and also on posterior margins of the first to fifth abdominal somites, a rostrum half as long as the carapace, 17 or 18 setae and spines on the antennal scale, and a total length of 4.7 mm) differs substantially from the first stage larva of *P. montagui,* known previously (211). Accordingly, Ivanov was led to separate *P. montagui tridens* as a distinct species, with the appropriate name, *P. tridens* Rathbun, 1902.

Haynes (120) generously provided a description of the nearly complete series of *P. montagui tridens* larvae obtained from plankton samples. Findings of Haynes confirm the report by Ivanov (145) that the first stage larva of the Pacific form differs from the Atlantic larva of *P. montagui* (211), and reveal that the observed differences persist throughout the larval life. He supports Ivanov's proposal to elevate the Pacific form to full specific status, as *P. tridens*.

Because of the marked dissimilarity of the 2 series of larvae, obvious differences in adult morphology between Pacific and Atlantic populations would be expected. The present writer has attempted to find attributes with specific value, using the specimens of *P. montagui tridens* from several British Columbia localities, and samples of *P. montagui* from England and Quebec, kindly supplied by P. J. Warren and R. Couture, respectively. Apart from the shape of the rostral tip (bifid or trifid, as observed by Rathbun), no basic differences were apparent in the structures examined, including external sex characters. Meristic counts and proportional measurements were made on individuals from the 3 populations (Table 2). Lengths of the rostrum and carapace, and the position of the anterior dorsal spine on the rostrum were measured by a vernier caliper; measurements of propodi and dactyli were made by an ocular micrometer. Numbers of observations vary among the 5 attributes in the 3 populations.

Numbers of specimens used to determine the relation of rostral to carapace length and number rostral spines were 63 and 82 in the *P. montagui* sample from England, and 21 and 34 from Quebec; 29 and 30 for *P. montagui tridens*. Numbers of measurements of the remaining characters varied between 9 and 14 of each character in the 3 populations.

Rathbun (217) separated the Pacific form from *P. montagui* because of its longer rostrum with trifid tip, and the position of the anterior dorsal spine within the proximal half of the rostrum. The present comparison (Table 2) corroborates her reported differences, though there is considerable overlap. There is only a tendency for the *tridens* form to have more rostral spines (including those on the carapace). Specimens in the British Columbia sample differed more from those in the Quebec sample than those from England, with respect to numbers of spines on dactyli of pereiopods III–V. Dactyli of these 3 pereiopods were significantly shorter (*t*-test at 95% confidence level), relative to their propodi, on Pacific specimens than those of individuals in both Atlantic samples. Proportional lengths of dactyli of pereiopods III and IV of English specimens were also significantly shorter than dactyli of the 2 pereiopods on Quebec specimens. The latter finding suggests that further research on Atlantic populations is appropriate.

TABLE 2. Comparison of meristic counts and proportional measurements on specimens of *P. montagui tridens* with specimens of *P. montagui* from two Atlantic populations. (Means in parentheses.)

Populations	Rostrum / Carapace	Rostral Formula	Position of dorsal anterior spine on rostrum	Spines on dactylus III	Spines on dactylus IV	Spines on dactylus V	Dactyus/Propodus III	Dactyus/Propodus IV	Dactyus/Propodus V
p. montagui tridens									
B.C. sample	1.3–1.8 (1.6)	9–13 6–8	.33–.47 (.39)	5–8	5–8	5–7	.177–.214 (.195)	.175–.214 (.187)	.141–.163 (.153)
P. montagui									
Quebec	1.4–1.6 (1.4)	9–11 5–7	.41–.53 (.47)	8–10	7–10	7–10	.288–.373 (.341)	.313–.361 (.335)	.174–.240 (.203)
England	1.1–1.5 (1.3)	8–11 5–6	.41–.51 (.44)	5–6	6–7	6–7	.200–.263 (.242)	.206–.274 (.250)	.185–.231 (.209)

Alone, the relatively shorter dactyli of *P. montagui tridens* may not be a sufficiently valid specific character. When taken with other attributes such as the longer trifid rostrum, the position of the anterior dorsal spine within the proximal half of the rostrum, color differences, and the different larval morphology, however, there appear to be sufficient grounds for elevating the Pacific form to full specific status, as *P. tridens*. Not mentioned by earlier writers is the fact that the Pacific form is geographically isolated from Atlantic populations, and presumably, because of the considerable morphological differences of larvae of the 2 forms, would not interbreed successfully if not isolated. Finally, it may be noted that *P. tridens* does not host the same parasites as *P. montagui*. The branchial isopod *Bopyroides hippolytes* infests *P. tridens*, and another isopod, *Hemiarthrus abdominalis*, infests *P. montagui* (10). The 2 parasites occur in both oceans (225). For additional reports on *P. montagui* see (8, 79, 235, 270).

Color Fine red dots over whole animal, with translucent background; darker red on cardiac and orbital regions of carapace, basicerite and peduncle of antenna, distal half of rostrum, pleopods, on lateral surface of sixth abdominal somite, and on dorsal surfaces of telson and uropods. Pereiopods have dark red blotches and bands, also canary yellow blotches more prominent on pereiopods III–V; third maxilliped has yellow tip. Antennal flagellum colored by alternate red and transparent bands; antennular flagella have red and white bands; yellow dots on dorsal surface of antennal scale (Plate 8B).

Distinctions Separated from other generally slender and thin-shelled species of the genus on the British Columbia coast, such as *P. jordani*, *P. borealis*, and *P. goniurus*, by more steeply ascending rostrum with trifid tip; absence of dorsal median carina or lobe on third abdominal somite; median dorsal spine on posterior margin of fourth somite.

Maximum lengths Males: carapace 15.0 mm, total 83 mm; females: carapace 22.4 mm, total 123 mm.

Range Cape Oyutorsky (178), Pribilof Islands (219), Bering Sea to San Nicolas Island, CA; 5–1984 m (232).

First collected in Canadian waters by the *Albatross* in Queen Charlotte Sound at 373 m, Aug. 31, 1888 (station 2861) (219).

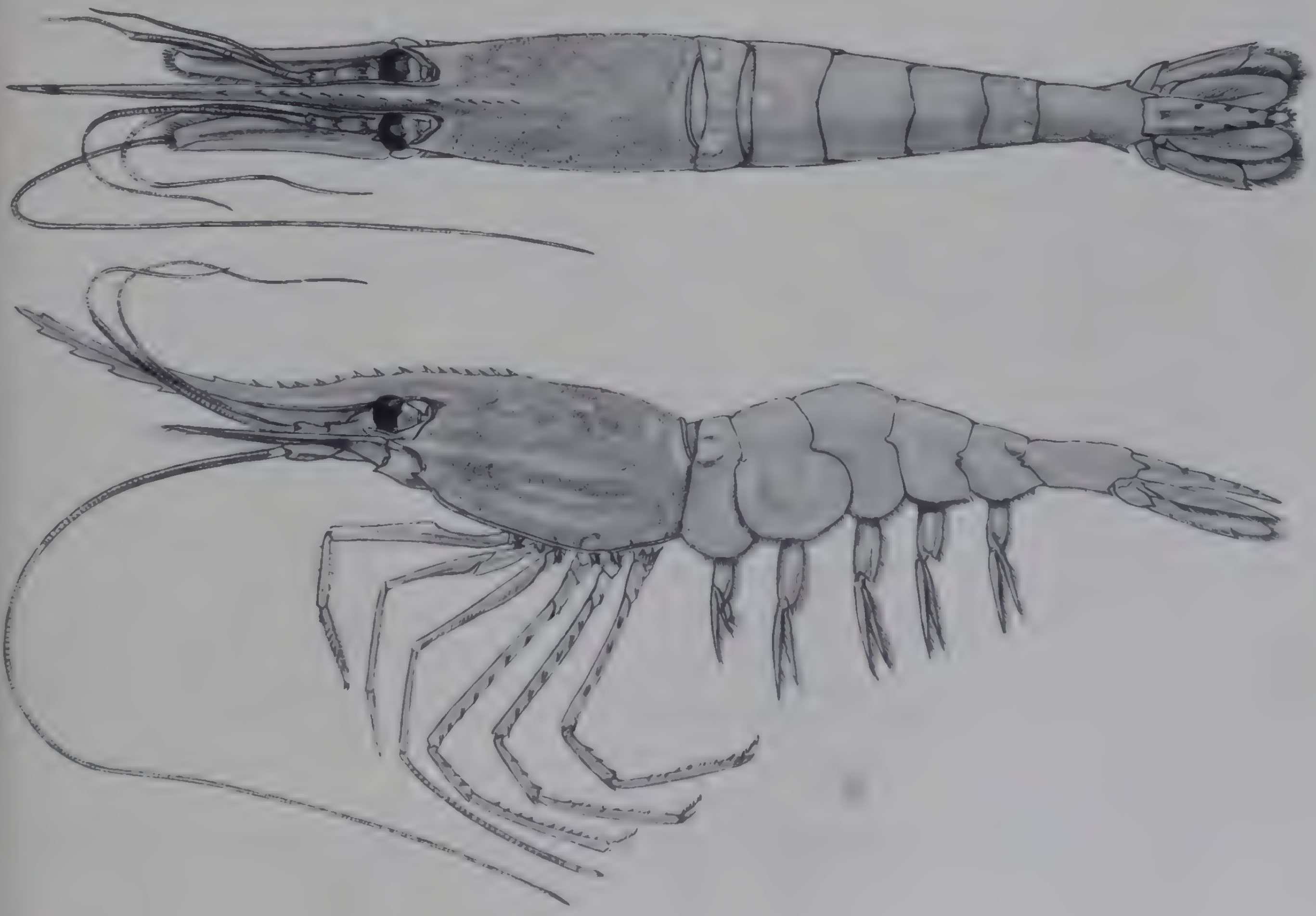
Biology and economics The species was found to be a protrandous hermaphrodite, but no early maturing females were apparent (57). There is an indication that some individuals of *P. tridens* change sex before the second autumn but normally males are active at 1½ yr. Males of *P. montagui* in the North Sea undergo sex change at 1 yr or so, and most apparently end the second year as active females (191). Thus, females of the Atlantic species are on the average smaller than *P. tridens,* which likely has a longer life span, to 4 yr (57). In the Strait of Georgia the ovigerous period lasts from late November to early April.

The first stage larva was described (145). More recently (120), the nearly complete larval series has been described from plankton samples. A branchial isopod, *Bopyroides hippolytes* (225), and the rhizocephalan, *Sylon hippolytes,* are parasites. Temperature and salinity ranges for *P. tridens* in southern British Columbia were 8.56–9.53°C and 29.24–30.54‰, respectively (57).

The yellow-leg pandalid is found more often in prawn traps fished on rocky bottom than in trawls towed on mud bottom, but is not recognized by fishermen as a commercial shrimp. It has been trawled and dredged on the upper continental slope (192–472 m) off La Perouse Bank.

PRAWN

Pandalus platyceros Brandt, 1851



Other common names: spot shrimp, spot prawn, spot

Description Body stout, little compressed. Shell thick, abdomen smooth, carapace pubescent. Rostrum moderately long to long, 1.2–2.0 carapace length, distal half ascending, $\frac{4\ 17}{6\ 8}$, dorsal spines movable except 1–5 distal, normally 1 solitary spine adjacent to acute tip. Carapace spines: antennal strong; pterygostomian moderate. Eye large, cornea well developed. Antennule: peduncle moderately long, second and third segments about equal; stylocerite short, distal end pointed; inner flagellum longer than outer, both longer than carapace. Antenna: scale longer than telson, moderately wide, outer margin concave, spine exceeds lamella slightly; basicerite, moderate upper lateral spine, lower strong spine; peduncle moderately long; flagellum equals or exceeds body length. Third maxilliped: moderately long, moderately stout; antepenultimate segment with slight lamina; epipod. Pereiopods: I shorter than third maxilliped, more slender; ischium with slight lamina; merus, proximal half flattened with lamina; carpus and propodus as in *P. borealis;* short terminal pegs; epipod; II chelate; epipod; left longer and more slender; ischium, proximal half flattened with lamina, 1 or 2 faint distal annulations; merus, two-thirds length with annulations; carpus, 27–31 segments; right ischium and carpus with no apparent annulations; carpus, 8 or 9 segments; III shorter than left longer than right of II, stout; ischium, 1 spine; merus, 7–11 and 7 or 8 spines; carpus, 3 and 1 spine; propodus, 13–19 spinules, 2 rows, dactylus stout, about 0.28 propodus length, 4–6 spines; epipod; IV shorter than III, as stout; ischium, 1 spine; merus, 7–9 and 5–7 spines; carpus, 3 spines; propodus, 8–22 spinules, 2 rows; dactylus stout, about 0.24 propodus length; 5 or 6 spines; epipod; V shorter than IV, as stout; ischium, 1 spine; merus, 5 or 6 and 5 or 6 spines; carpus, 3 spines; propodus, 17–23 spinules, 2 rows; dactylus stout, about 0.3 propodus length, 6 or 7 spines. Abdomen: dorsal posterior margin of third somite produced slightly; posterolateral margins of third, fourth, and fifth somites widely recessed at articular knobs; pleuron of fourth with strong ventral spine; fifth with strong posterolateral spine; sixth shorter than telson, depressed somewhat, strong posteroventral spine with moderate lateral extension, giving a flared margin in dorsal view; telson moderately wide, tapering to blunt tip, 4–6 pairs dorsolateral spines; uropods about equal, reaching tip of telson.

Color Color illustration (Plate 2A) of an adult shows a basic overall color of "washed out" red, darker on carapace due to pubescence; other adults are fawn or tan. Three or 4 lateral white stripes prominent on carapace; longest and widest stripes extend from antennal and ptyergostomian spines posteriorly for most of carapace length. Conspicuous round white spots, pair on dorsolateral surface of each of first and fifth abdominal somites give species common names in use elsewhere on the coast of North America. Alternating red and white bands on third maxilliped, pereiopods, and flagella of antennule and antenna. Juvenile specimens in shallow water, among eelgrass, sea lettuce *(Ulva),* apron kelp *(Laminaria),* and red algae are correspondingly green, brown, or red; white marking on body barely visible. Young animals normally have more white stripes and dots than adults; former appear on carapace, either medially or adjacent to dorsal spines; additional pairs of white dots occur on dorsolateral surface of second abdominal surface and membrane between first and second somites. Fine blue spots occur in pairs on anterior dorsal surfaces of first to third somites, also 2 or 3 spots along cardiac and gastric regions of carapace.

Distinctions Characterized by stout body; carapace almost entirely pubescent; absence of dorsal spines on posterior half of carapace. On living specimens, and persisting for some time in preservative, are 3 or 4 lateral white stripes on lateral surface of carapace; and 2 large white spots on each of dorsal surfaces of first and fifth abdominal somites.

Maximum lengths Males: carapace 48.1 mm, total 230 mm; females: carapace 61.1 mm, total 253 mm.

Range Unalaska Island, AK to off San Diego, CA (219); Sea of Japan, Hokkaido, Toyama Bay, Vladivostok; Korea Strait, Nagasaki; intertidal to 487 m (59).

One small specimen was found by G. M. Dawson in 1878 by "shallow dredging, Port Simpson to north end of Vancouver Island," that is, somewhere within a region covering the greater part of the provincial coastline. This first known specimen was recorded as *Pandalus pubescentulus* Dana, 1852 (242).

Biology and economics Knowledge of the life history of *P. platyceros* in southern British Columbia is based on the work of Canadian authors (31, 57). Larvae hatch in March or April in the adult habitat of 70–90 m. By midsummer late larvae and postlarvae prawns are in shallower regions (54 m or less), where they remain through the autumn and part of the winter; some metamorphose and settle where hatched. A year after hatching, most prawns (21.1 mm carapace length and weighing about 6.5 g) are again on adult grounds. Prawns first mature as males in their second autumn (27.0 mm carapace length and 13 g) and most will function as males for another year; the remainder begin sex change around the time of their second birth date. At about 30 mo there is a mixed group of males (32.9 mm carapace length and 23 g) and females breeding at a slightly larger size. By the end of 3 yr all males have either completed, or are undergoing sex change; 1 yr later, after larvae are hatched, practically all females (38 mm carapace length and over 35 g) leave the rocky trapping region (70–90 m) and are never seen again, leading to the conclusion that most die. Females, 43–50 mm carapace length, caught occasionally by trawling 110 m and deeper, are presumably fast growing individuals in their fourth year or others in the fifth year. Normally spawning is over at the end of October and the ovigerous period lasts 5–5½ mo.

Adult prawn live on what is generally known as a rocky bottom. Recent previously unreported direct observations during the day from a submersible, *Pisces IV* (75–100 m), revealed they are found in crevices on rock faces, or in lairs under boulders. They are in general inactive and undisturbed by bright artificial lights. Trawling in Hood Canal, WA, revealed a greater number of prawns caught at shallower depths (18–49 m) at night and more in deeper water (51–73 m) during the day, suggesting the species has a diel migration behavior pattern (75). Larvae were described from Burrard Inlet (31), on the basis of the first stage hatched in the laboratory, and plankton collections of the second, fourth, and sixth stages. More recently, first to ninth stages were reared and described fully (213), showing that the fifth stage is postlarval. Mean egg count of 21 females, 33.5–41.4 mm carapace length, from the Strait of Georgia, was 2028 (59). Near Petersburg, AK, the mean egg number was 3900, based on partial counts of 5 females (137). Stomachs of 24 prawns, collected near Vancouver, had remains of polychaete worms belonging to 4 families, and unidentified crustaceans (59). Temperature and salinity ranges for the species in the Strait of Georgia were 7.61–10.97°C and 26.42–30.83‰, respectively (57).

Structure and function of the male reproductive organs, particularly the androgenic gland was studied at Friday Harbor (125). The male phase was prolonged in individuals about to change sex, on removal of eyes and stalks (124). There is 1 record of a rhizocephalan, *Sylon hippolytes,* infesting a male prawn (59). Unpublished information is that the local octopus and the yelloweye rockfish are predators.

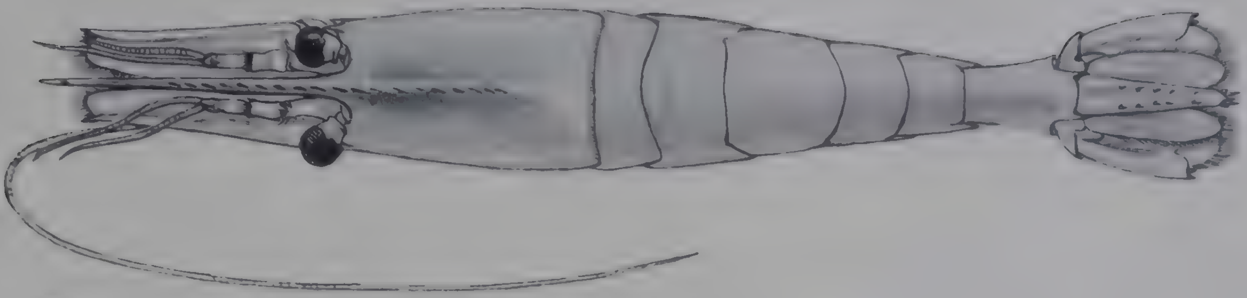
There is little detailed information on the early history of the prawn trap fishery on the British Columbia coast. The main reason for this, apparently, is that, before the early 1950s, prawn landings were not recorded separately; and there are unreported dockside sales by fishermen; also, prawn fishermen were inclined to be secretive, lest the location of favorite grounds was revealed to competitors. A guess is that prawn fishing began sometime before World War I in Howe Sound. The fishery did not assume even minor importance until after World War II. In the late 1940s, Mr W. Butterfield, from a base at Allison Harbour, fished prawns in nearby Seymour and other inlets. His catches were frozen and shipped to Vancouver every week on a Union Company steamship. In the early 1950s, trapping began in Knight and Kingcome inlets; this region led the rest of the coast in prawn production until about 1970. By 1960, several operating prawn vessels were equipped with refrigerated holds. In the same year, fishermen owned, and presumably fished, 1260 traps (13). The following decade saw an expansion of the fishery; in 1965 the gear inventory stood at 2710 traps (14), deployed on a more or less regular basis on grounds in Rivers Inlet, Loughborough Inlet, Howe Sound, near Texada Island, Lund, and Nanaimo. Also over this period, fishermen were turning away from the traditional daily setting and lifting of traps in deep water (64–90 m) to overnight sets in the shallows (12–27 m), thereby increasing the effective fishing effort. On the west coast of Vancouver Island, trapping started in Nootka Sound around 1968, although there had been sporadic activity in Effingham Inlet earlier. Fishing has continued to the present day in the above areas, along with some operations near Namu, Bella Bella, and elsewhere. Trends in production are not apparent in recorded landing statistics, but fishermen report decreased availability on a number of grounds. No regulation is now in effect. *P. platyceros* is fished commercially in Alaska and Washington as the spot shrimp, and in California as the prawn, or spot prawn. Fewer sportsmen fish prawns than Dungeness crabs *(Cancer magister)*, supposedly because of the labor entailed in lifting traps from deeper water. Trap construction and fishing methods are illustrated in a popular manual (278).

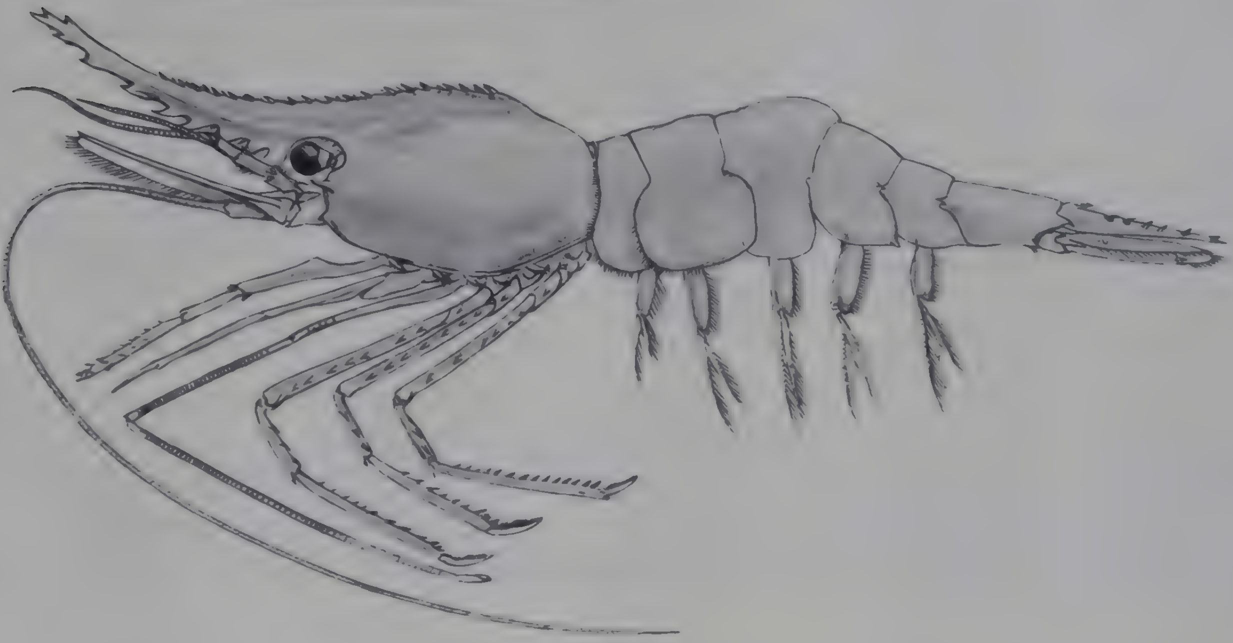
The Pacific Biological Station in Nanaimo had a role in development of the fishery, in addition to studies on prawn biology. Exploration was conducted in 1954 (62); trap testing in 1967 and 1968 (296); and in 1974 and 1975, further successful exploration on the coast from Rivers Inlet to Douglas Channel (65, 44).

There has been interest in farming *P. platyceros*. In Britain (280), the offspring of imported ovigerous females grew to an edible size, e.g. in 1 season or 7 mo; maintaining a breeding population was a problem, as females held in Britain after hatching larvae showed no ovarian development. Relatively slow growth rates and poor food conversion ratios in culture experiments in California led to the conclusion that, at present, prawn culture is economically questionable (150).

HUMPBACK SHRIMP

Pandalus hypsinotus Brandt, 1851





Other common names: coonstripe, king shrimp, helmet shrimp (Korea), yamato ebi (Japan)

Description Body stout, little compressed. Shell thick, surface smooth. Rostrum moderately long, 1.2–1.7 carapace length, distal two thirds ascending steeply, $\frac{17\text{-}22}{7\text{-}9}$, dorsal movable except solitary distal spine, tip oblique, bifid. Dorsal profile of carapace arched strongly. Carapace spines: antennal strong; pterygostomian moderate to weak. Eye moderate, cornea well developed. Antennule: peduncle moderately long, third segment about a third as long as second; stylocerite short, distal end rounded; inner flagellum longer than outer, both shorter than carapace. Antenna: scale longer than telson, moderately wide, outer margin slightly concave, spine exceeds lamella slightly; basicerite, moderate upper lateral spine, lower pronounced spine; peduncle short; flagellum almost as long as body. Third maxilliped: moderately long, moderately stout; antepenultimate segment with slight lamina, lower distal spine; epipod. Pereiopods: I shorter than third maxilliped, more slender; ischium, slight lamina; merus, proximal half flattened with lamina; carpus and propodus as in *P. borealis;* short terminal pegs; epipod; II chelate; epipod; left longer, more slender; ischium, proximal half with lamina, about 6 faint distal annulations; merus, almost entire length with annulations; carpus, 60 or more segments; right ischium and merus with no apparent annulations; carpus, 20–23 segments; III shorter than left, longer than right of II, stout; ischium, 1 or 2 spines; merus, 9 or 10 and 7–10 spines; carpus, 3 and 1 spine; propodus, 18–26 spinules, 2 rows; dactylus slender, about 0.4 propodus length, 20 or more spines, proximal minute; epipod; IV shorter than III, as stout; ischium, 1 spine; merus, 8 or 9 and 7-9 spines;

carpus 3 and 1 spine; propodus, 18–26 spinules, 2 rows; dactylus slender, about 0.43 propodus length, 14–20 spines; epipod; V about as long as IV, as stout; ischium, 1 spine; merus, 6 or 7 and 5 or 6 spines; carpus, 2 or 3 and 1 spine; propodus, 19–31 spinules, 2 rows; dactylus, slender, about 0.3 propodus length, 7–11 spines. Abdomen: dorsal posterior margin of third somite produced slightly; posterolateral margins of fourth and fifth widely recessed at articular knobs; pleuron of fourth with moderate to strong ventral spine; posterolateral spine of fifth strong; sixth shorter than telson, deeper at proximal end, strong posteroventral spine extended laterally, giving a flared margin in dorsal view; telson moderately wide, tapering to blunt tip, 5 or 6 pairs dorsolateral spines; outer uropod shorter than inner, neither reaching tip of telson.

Color Background light tan. On carapace, pinkish area on midlateral surface overlaid with fine red dots; in cardiac region extending to base of posterior dorsal spines, chocolate brown to sooty black, overlaid on lower edge with mottling of red dots; other red spots on branchial and orbital regions, along bases of dorsal spines of carapace and rostrum; also white spots in hepatic region. Abdomen has chocolate brown on dorsal and posterior parts of sixth somite, and on tail fan; stripe of same color on dorsal surfaces of fifth and fourth somites, mixed with rust on latter; brown to sooty black blotches on dorsal and lateral surfaces of first to fifth somites; blotches of red spots mainly on first to fifth pleura and protopodites of pleopods. Pereiopods and third maxilliped have alternating light tan and chocolate brown bands for entire lengths of these appendages, except on pereiopod II, where bands occur only on ischium and merus. Banding also present on antennular flagella, and antennal flagellum (Plate 7A).

Distinctions Known by stout body; smooth surface; strongly arched dorsal profile of carapace; sharply ascending rostrum; many (17–22) dorsal spines, extending into posterior half of carapace; elongate dactylus of pereiopod III with over 20 small spines on the flexor margin.

Maximum lengths Males: carapace 29.4 mm, total 151 mm; females: carapace 39.6 mm, total 192 mm.

Range St. Michael, Norton Sound, AK. Juan de Fuca Strait, and Puget Sound (219); western Bering Sea, Cape Navarin (178), Bering Island; Okhotsk Sea; Sea of Japan, Hokkaido, Korea; Korea Strait, Nagasaki; 5–460 m (266).

There was no published record of *P. hypsinotus* in British Columbia waters until 1929, when it was described as a commercial species (29).

Biology and economics The life history of the humpback shrimp in southern British Columbia waters is known (31, 57). Larvae hatch in late March or April and metamorphosis occurs in the adult habitat (65–82 m), or in shallower water (37–55 m). This shrimp matures as a male, and in varying proportions as a female, at about 1½ yr, with a carapace length of 24.1 mm and weighing 10.3 g. Early maturing females of the age group carry eggs over the winter, and the remaining males start their sex change from March to May, when about 2 yr of age. After about 4 or 5 molts, transition to the female phase is complete; just prior to breeding, all individuals age about 30 mo are mature females, on the average measure 130 mm, and weigh about 13 g. Egg bearing begins in late November or early December and lasts until the spring, when these females are 36 mo old. Subsequent survival into the fourth year appears low, based on the paucity of large females in the populations sampled.

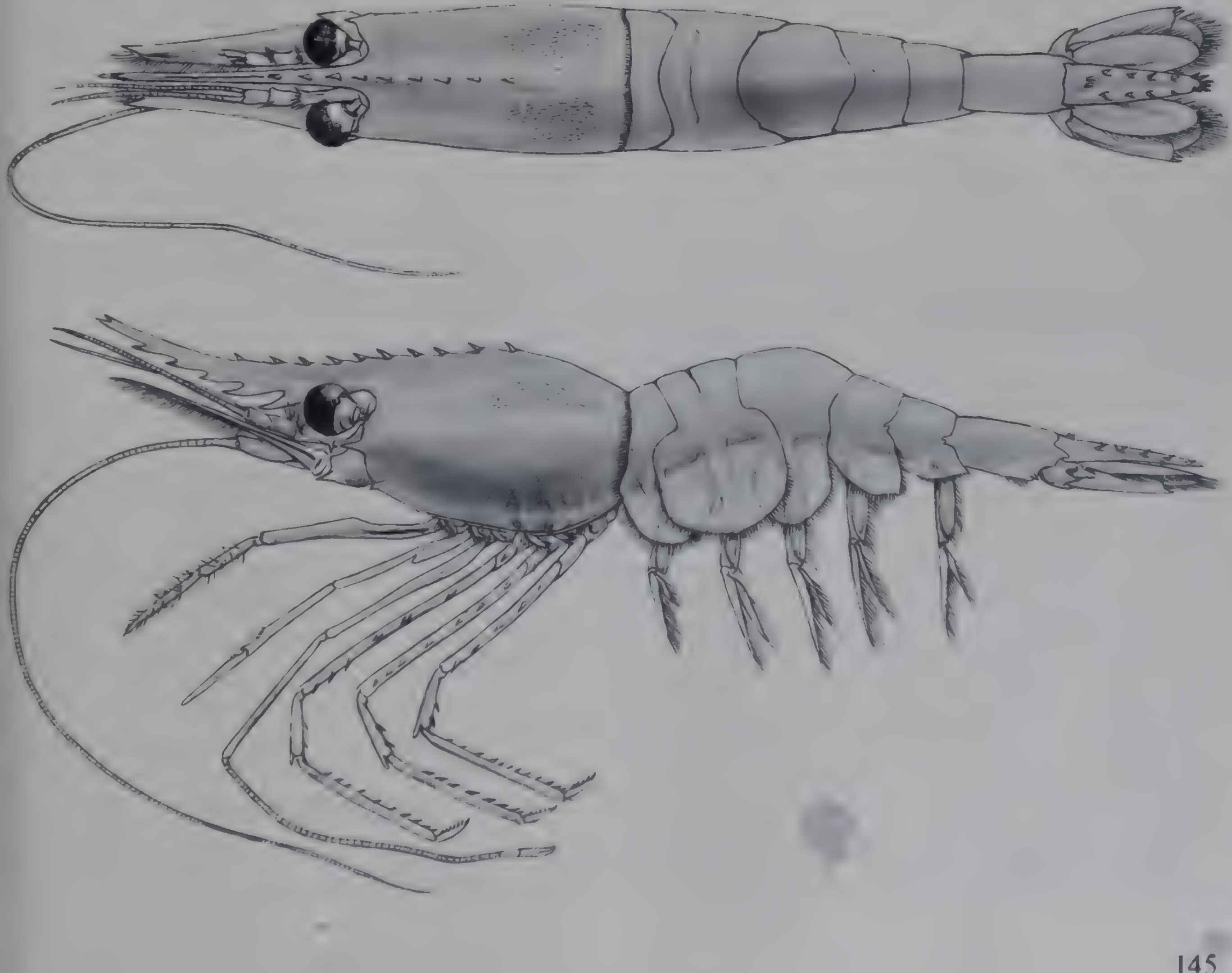
In the Strait of Georgia, the mean egg count for 15 females, 24.7–31.2 mm carapace length, was 2257. An average estimate, based on partial counts for 5 ovigerous females from the Alaska coast, was 4000 eggs (137). A study in Hokkaido (138) revealed that *P. hypsinotus* matured as a male at 2 yr, changed sex at 3 yr, and lived another year when it produced a brood of eggs, which were carried from September to March. Average egg counts for Hokkaido female shrimps, 10.2–15.0 mm, were 264–3000 (138).

The first stage larva was hatched in the laboratory, from a female caught in Burrard Inlet, but no later stage was determined definitely (31). There is another description of larvae, based on research around Hokkaido (163); the first stage from laboratory rearing, and the second to fifth stages from plankton samples. More recently, 6 zoeal stages and 3 postzoeal stages were reared in Kachemak Bay, AK, and described fully (116). Reported temperature and salinity ranges for the species in the Strait of Georgia were 7.44–11.08°C and 25.88–30.56‰, respectively (57). The sand sole is a predator (189). The diet of specimens caught in Burrard Inlet consisted mainly of mysids *(Neomysis franciscorum),* and other unidentified crustaceans; polychaete worms such as *Nephthys* sp. were also eaten (A. B. Needler unpublished data).

P. hypsinotus is caught as an incidental species in shrimp trawling operations in Stuart Channel and Burrard Inlet, and in prawn trapping in Knight Inlet and Kingcome Inlet and elsewhere. A limited trawl fishery in Clio Channel operated for a while in 1949. In Alaska waters this shrimp, known there as the coonstripe, is recognized as a commercial species, but contributes relatively little to total trawl and trap landings (22).

ROUGH PATCH SHRIMP

Pandalus stenolepis Rathbun, 1902



Description Body stout, little compressed. Shell thick, abdomen smooth, patch of pubescence on cardiac region of carapace. Rostrum moderately long, 1.2–1.4 carapace length, distal two-thirds ascending sharply, $\frac{8-12}{5-7}$, all dorsal movable, tip bifid. Carapace spines: suborbital angle slightly rounded; antennal strong with supporting carina; pterygostomian moderate to weak. Eye large, cornea well developed and almost spherical. Antennule: peduncle short, third segment subequal to second; stylocerite short, distal end rounded; flagella about equal, shorter than carapace. Antenna: scale narrow, longer than telson, outer margin slightly concave, spine exceeds lamella, latter narrower distally than thickened axis, basicerite, upper lateral lobe, lower strong spine; peduncle short; flagellum shorter than body. Third maxilliped: moderately long, moderately stout; antepenultimate segment with slight lamina; epipod. Pereiopods: I about as long as third maxilliped, more slender; ischium with slight lamina; carpus and propodus as in *P. borealis,* short terminal pegs; epipod; II chelate; epipod; left longer, more slender; ischium, proximal half flattened with lamina, about 3 faint distal annulations; merus, two-thirds length with annulations; carpus, 50 or fewer segments; right ischium and merus with no apparent annulations; carpus, 10–13 segments; III shorter than left, and longer than right of II; moderately stout; ischium, 0 or 1 spine; merus 6 or 7 and 5 spines; carpus, 2 and 1 spine; propodus, 18–22 spinules, 2 rows; dactylus moderately stout, about 0.26 propodus length, 5–9 spines; epipod; IV slightly shorter than III, as stout; ischium, 1 spine; merus 5–7 and 5–7 spines; carpus, 2 and 1 spine; propodus, 14–18 spinules, 2 rows; dactylus, moderately stout, about 0.27 propodus length, 5–9 spines; epipod; V shorter than IV, as stout; ischium, 0 or 1 spine; merus, 5 and 3 or 4 spines; carpus, 2 spines; propodus, 15–23 spinules, 2 rows; dactylus moderately stout, about 0.24 propodus length, 5–7 spines. Abdomen: second somite with distinct transverse dorsal sulcus; dorsal posterior margin of third produced moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; pleuron of fourth with weak ventral spine; fifth with strong posterolateral spine; sixth shorter than telson, depressed slightly, with moderate posteroventral spine; telson moderately wide, tapering to blunt tip, 4 or 5 pairs dorsolateral spines; uropods about equal, both reaching, or exceeding tip of telson.

Color Background white to gray. On carapace, red dots form patches from cardiac region to posterior branchial region, in midbranchial and hepatic regions, and from gastric to orbital region; band of closely spaced dots on anterolateral margin from pterygostomian spine, past orbit to lower base of rostrum; also red patches along dorsal surface at bases of spines on carapace and rostrum; also on rostrum, several small red patches mainly near distal ventral spines; large yellow dots on midbranchial and posterior branchial regions; 2 blue dots on each side in cardiac region, posterior to pubescent patch. On abdomen, red dots, closely spaced in patches, on dorsal and upper lateral surfaces of first and fifth somites, on anterior parts of second to fourth somites; more patches scattered on lower parts of pleura and protopodites of pleopods; yellow dots and patches on lower anterior part of first somite, over most of lower half of second pleuron; red patch on anterior lateral surface of sixth somite; blue spots, 2 on anterior dorsal surface of first somite; 2 on each side, one above the other, posterior to sulcus of second somite; 2 on anterior upper lateral surface of third somite; on fourth somite, 2 on each side, 1 on anterior upper lateral surface, the other near posterolateral margin, below articular knob. Anterior appendages, patch of red dots on eyestalk; patches form banding on all segments of pereiopods, except dactyli of pereiopods III–V, but sparse on carpus of II, merus of IV, and propodus of V; third maxilliped colored similarly, with reddish setae on 2 more distal segments; banding on outer antennular flagellum; almost solid light red to pinkish on antennal flagellum, darker red on peduncle and basicerite; and setae of scale and outer margin pinkish (Plate 2C).

Distinctions Recognized by stout robust body; relatively short, ascending rostrum with normally bifid tip; relatively few dorsal spines (8–12), all movable, extending behind middle of carapace; antennal scale with lamella distally narrower than supporting axis; patch of pubescence on cardiac region of carapace.

Maximum lengths Males: carapace 14.4 mm, total about 76 mm; females: carapace 18.2 mm, total 82 mm.

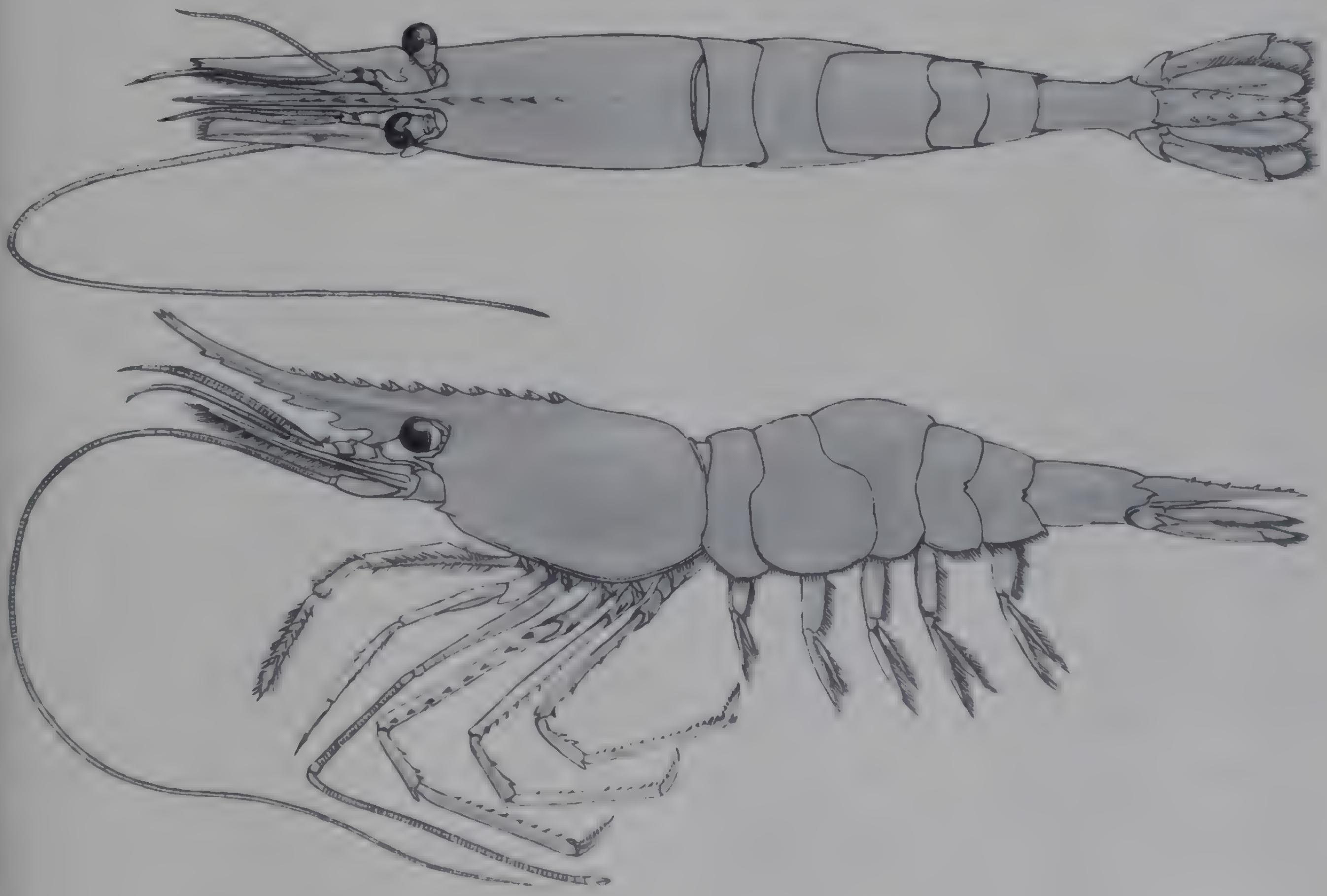
Range Unalaska Island, AK, to Hecata Bank, OR, 49-229 m (219).

First found on the British Columbia coast by the *Albatross* off Amphitrite Point at 62 m, Sept. 25, 1888 (station 2879) (219).

Biology and economics The species is hermaphroditic (57). Six zoeal stages and the first postlarval stage were described (198). Growth rate and age at sex change are unknown. The ovigerous period in the Strait of Georgia is from November to early April. Specimens are caught in prawn traps and by trawling on mud bottom but not in quantities to be of value commercially.

COONSTRIPE SHRIMP

Pandalus danae Stimpson, 1857



Other common name: dock shrimp

Description: Body stout, compressed. Shell thick, surface finely pitted. Rostrum moderately long, 1.0-1.6 carapace length, distal two-thirds ascending, $\frac{10-12}{6-8}$, all dorsal movable, distal half lacks spines, tip trifid. Carapace spines: antennal and pterygostomian strong. Eye large, cornea well developed. Antennule: peduncle short, third segment subequal to second; stylocerite short, distal end rounded; inner flagellum longer than outer, both shorter than carapace. Antenna: scale narrow, spine exceeds lamella, latter wider distally than thickened axis; peduncle short; flagellum about equals body length. Third maxilliped: moderately long, moderately stout; antepenultimate segment with slight lamina; epipod. Pereiopods: I slightly shorter than third maxilliped, more slender; ischium with slight lamina, proximal half flatted with lamina; carpus and propodus as in *P. borealis;* short terminal pegs; epipod; II chelate; epipod; left longer, more slender; proximal half of ischium with lamina, about 5 faint distal annulations; merus, almost entire length with annulations; carpus, about 60 segments; right; no apparent annulations on ischium, about 6 on distal half of merus; carpus, 18–21 segments; III shorter than left, longer than right of II, moderately stout; ischium, 1 or 2 spines; merus, 6–9 and 3–8 spines; carpus, 1–3 and 1 spine; propodus, 20–31 spinules, 2 rows; dactylus moderately stout, about 0.3 propodus length, 6–13 spines; epipod; IV shorter than III, as stout; ischium, 1 spine; merus, 5–9 and 3–7 spines; carpus, 2 or 3 and 1 spine; propodus 17–33 spinules, 2 rows; dactylus moderately stout, about .28 propodus length, 5–11 spines; epipod; V shorter than IV, as stout; ischium, 1 spine; merus, 4–6 and 3 or 4 spines; carpus, 2 or 3 and 1 spine; propodus, 21–33 spinules, 2 rows; dactylus moderately stout, about 0.3 propodus length, 6–8 spines. Abdomen: second somite with slight dorsal transverse sulcus; dorsal posterior margin of third produced moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; pleuron of fourth with weak ventral spine; fifth with strong posterolateral spine; sixth shorter than telson, slightly compressed, with strong posteroventral spine extended laterally to give a flared margin in dorsal view; telson moderately wide, tapering to blunt tip, 5 or 6 pairs dorsolateral spines; uropods about equal, reaching or exceeding tip of telson.

Remarks Pereiopods III and IV of male differ from those of female by having shorter propodi, with that of pereiopod III recurved distally (see Fig. 8C), to form an oblique margin against which dactylus folds (219).

Color The individual illustrated (Plate 4A) has a milky, translucent background, with irregular striping and spots of chocolate brown on lateral and dorsolateral surfaces of all abdominal somites and telson; lying between stripes, and especially along dorsal surface including uropods, are patches of fine brick-red dots. Pleopods have basiopodites with scattered small brown patches, endopods and exopods mainly brick-red. On carapace, most small brown spots on hepatic and posterior branchial regions; on posterolateral surface, wide swath of fine brick-red dots. This coloration also seen in orbital and frontal regions, along lateral surface and at tip of rostrum, on basicerite and peduncle of antenna, and antennular peduncle. Eyestalk with outer red-brown patch; bands of much the same hue on all flagella. Brown spots and bands on third maxilliped and pereipods. Fine blue spots on cardiac region of carapace, on dorsal surfaces of first to third somites. On dorsolateral surfaces of first to third abdominal somites, striping and spots on other individuals vary in shades of brown and red, and some have white markings.

Distinctions Separated from *P. stenolepis*, which also has a stout body, a relatively short, ascending rostrum, and a dorsal transverse sulcus on the second abdominal somite, by its antennal scale, with lamella wider distally than thickened outer axis; rostrum with tip normally trifid; lack of any pubescence on the carapace; eyes conical (including stalk), rather than almost spherical.

Maximum lengths Males: carapace 26.0 mm, total about 123 mm; females: carapace 29.2 mm, total about 140 mm.

Range Resurrection Bay, AK (250, 43), to Point Loma, CA; intertidal to 185 m (290). The first known collection of the species was in Esquimalt Harbour in 1862 (25).

Biology and economics The coonstripe shrimp was the first pandalid found to be a protandrous hermaphrodite (30). Although ovigerous females occur throughout the year, the main season appears to extend from November to April. The 5 larval stages remain near the place of hatching, at 18–54 m, approaching bottom as development progresses. By late June, metamorphosis is complete, and growth is rapid until October when, at a carapace length of 12.8 mm and body weight of almost 2 g, the shrimps become active males. A recent laboratory study (181) has shown that some individuals will mature directly as females. Some of those functioning as males first will do so again a year later, at a carapace length of 17.3 mm and weight of 4.4 g; most, however, change sex over the period and mature as females, at a carapace length of 18.0 mm and weight of about 5 g. Sex change of second-year males begins as early as January and continues throughout the third spring and summer. In the fall, the third-year females, then active, may have an average carapace length of 21.7 mm and weight of 8.5 g. The life span of the species is 36 mo or less.

In the Strait of Georgia, the mean egg count for 36 females 13.8–24.8 mm was 1139. The first stage larva is known from a laboratory hatching, but the second to sixth stages were described from plankton collections (31). The rhizocephalan, *Sylon hippolytes*, is a parasite of the coonstripe shrimp (66, 239), though incidence of infestation appears low. The ling cod is a predator (286). In Burrard Inlet the main food was polychaete worms, especially *Sabellaria cementarium* Moore, 1906 and *Harmothoe* sp. (A. B. Needler, unpublished data). The musculature is known in detail (28). Observations on the mating behavior were summarized (32).

P. danae in southern British Columbia appears to prefer a gravelly or sandy bottom at depths 22–64 m (31). These conditions, along with a moderate to strong tidal movement, are found in Burrard Inlet, between Second Narrows and Deep Cove, a coonstripe fishing ground for many years. In San Francisco Bay, most specimens were caught on coarse sand, gravel, and stones, some to 36 cm at 49–79 m, temperature above 12°C, and salinities greater than 25.7‰ (232). Temperature and salinity ranges for this shrimp in Burrard Inlet were 7.37–12.32°C and 25.23–30.06‰, respectively (57).

Reportedly, *P. danae* was sold in Victoria early in this century (258). Before World War II and for some years after, the Burrard Inlet fishery contributed substantially to the annual shrimp production. By about 1960, however, the species was no longer present in commercial quantities. The cause of the decline remains unexplained. A long-established winter trap fishery continues in Sooke Harbour.

The other common name, dock shrimp, was given presumably because of the habit of living, at least in late summer and autumn, on or around the wooden and concrete supporting structures of wharves. Some years ago, when fishing was permitted in Vancouver Harbour, shrimps were caught for home consumption and for sale by a basketlike net shaped to scrape the shrimps off piles and concrete walls as it was lifted to the surface. A popular manual (278) describes shallow-water fishing for this shrimp. Baited ring traps are operated at night from late August to early October in Canoe Bay, and around wharves near Sidney.

Family ALPHEIDAE Randall, 1839

Rostrum, if present, unarmed. Eyes usually covered by carapace. Mandibles with incisor process and palp of two segments. First pair of pereiopods often with one chela, or both chelae powerfully developed. Second pair of pereiopods minutely chelate, long, slender, equal, with carpus segmented. Telson usually broad, rounded.

Members of this family are small shrimps, living for the most part in tropical and subtropical seas. At least 20 genera are recognized (131, 295). Many species, particularly those in the genus *Alpheus*, are known as "snapping" shrimps (20) because they produce a clicking sound with the large cheliped. The sound of numerous individuals performing, when received under water by a hydrophone, reportedly resembles the hissing and crackling of food frying. Two species, *Alpheus euphrosyne* DeMan, 1897 and *A. microrhynchus* DeMan, 1897, have economic value in southeast Asia (135).

One genus, *Betaeus*, is represented in Canadian Pacific waters.

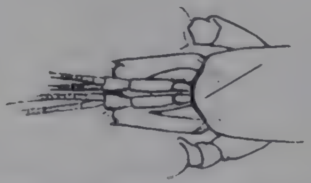
Genus *Betaeus* Dana, 1852

Rostrum not present; front not spined, either emarginate between eyes or evenly rounded. Chelae usually similar, inverted so that dactyli are on the lower side. Carpus of second pereiopod with five segments. Sixth abdominal somite with movable plate articulated at posteroventral angle. Telson broad. Outer margin of outer uropod, or exopod, with two distal spines, outer immovable, inner movable, and normally long and robust. Exopod on third maxilliped. Epipods on at least first two pereiopods.

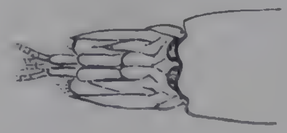
Seven species of *Betaeus*, occurring on the west coast of North America, were described fully (III) from which the present writer has freely extracted diagnoses of the family and genus, species descriptions, lengths, ecological and color notes. In this Bulletin the two local species, *B. harrimani* and *B. setosus*, are termed "hooded shrimps," because of the forward projection of the carapace to shade the eyes. Both species apparently are very secretive and difficult to detect in the intertidal zone, if the paucity of preserved specimens is a valid criterion. Their larvae are distinguished from those of other British Columbia caridean shrimps by the fifth pereiopod, which develops early, is much longer than other pereiopods, and bears an elongated apical spine (112).

The generic name is derived from the name of the second letter of the Greek alphabet, *β*, or beta. The name is appropriate for a genus in the same family to follow *Alpheus* J. C. Fabricius, 1798 named obviously after the first Greek letter, *α*, or alpha.

Key to species of genus *Betaeus*



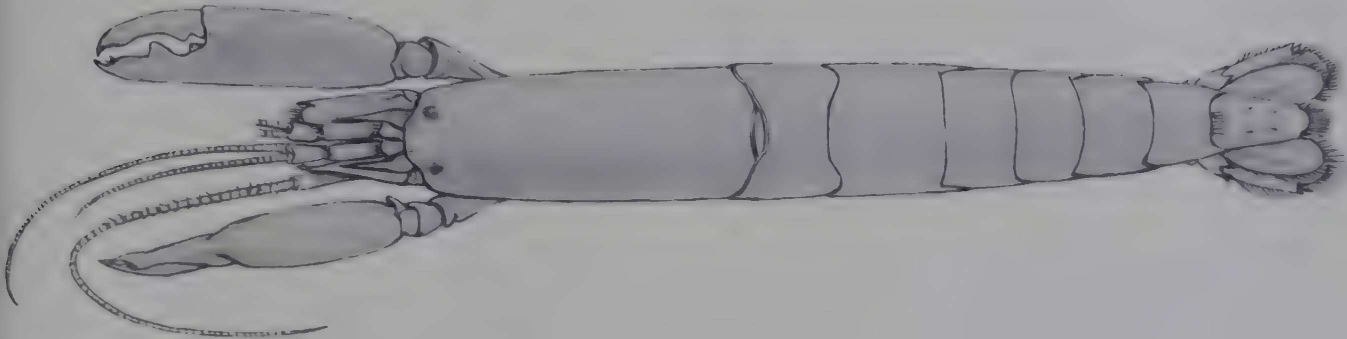
1 Dorsal frontal margin of carapace straight or slightly convex; chelae of first pereiopods oblong in shape .... Northern hooded shrimp, *B. harrimani* (p. 151)

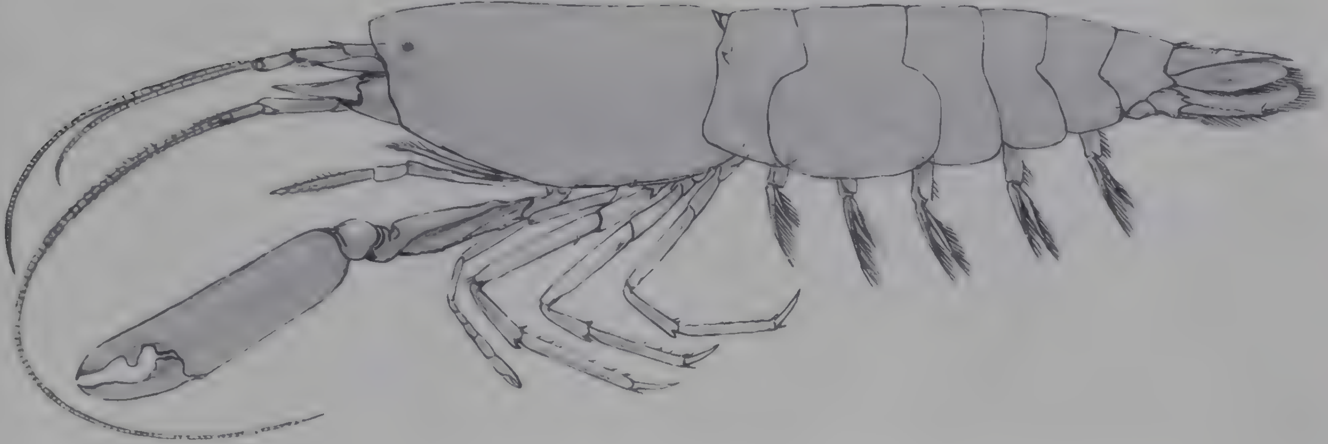


Dorsal frontal margin of carapace deeply indented; chelae of first pereiopods oval shaped .... Fuzzy hooded shrimp, *B. setosus* (p. 153)

NORTHERN HOODED SHRIMP

Betaeus harrimani Rathbun, 1904





Description *Female* Body deep, somewhat compressed. Shell thin, mainly smooth, scattered minute setae. Carapace: dorsal frontal margin straight or slightly convex; lateral frontal margin with 2 shallow sinuses; posterolateral margin deeply notched adjacent to cardiac region. Eye round, stout, stalk with sharp spine on inner margin. Antennule: peduncle long, first segment with keellike ventral tooth, second segment longer than third; stylocerite moderately long, acute tip; inner flagellum longer than carapace, outer appreciably shorter. Antenna: scale shorter than telson, moderately wide, outer margin straight, spine exceeds lamina slightly, separated from it by short slit distally; basicerite, upper lateral lobe, strong lower spine; peduncle long; flagellum longer than carapace, flattened, proximal half with setae. Third maxilliped: moderately long, moderately stout; proximal segment flattened, twisted; penultimate segment about half length of distal; exopod; epipod. Pereiopods: I about twice length of carapace, very stout; merus shorter than chela, somewhat triangular in cross section and flares distally, 2 tuberculate ridges ventrally, separated by sinus, outer surface with broad oblique sinus devoid of tubercles, inner surface has a longitudinal sinus and distally a deep transverse sinus, scattered tubercles over much of surface; chela inverted, varies greatly in proportion, length, width, and dentition of propodus and fingers, normally fingers about half as long, but occasionally subequal to propodus, chela with large tooth on fixed finger and concave margin of dactylus more common than type with fairly straight, finely denticulated; inner margins of fingers, tips curved, interlocking, surface finely tuberculate, spinose, with fine pubescence especially dorsally; epipod; II almost three quarters length of I, slender; carpus, 5 segments; chelate; epipod; III longer than II, stouter; merus, inflated proximally, 1 spine; carpus, 2 distal spinules; propodus, about 10 spinules, 1 or 2 rows; dactylus slender, about 0.4 propodus length; epipod: IV shorter than III, as stout; merus, 1 spine; carpus, 2 distal spinules; propodus, 8–10 spinules, 1 or 2 rows; dactylus slender, about 0.44 propodus length; epipod: V shorter than IV, as stout; merus, 1 spine; carpus, 2 distal spinules; propodus, 8–10 spinules, 1 or 2 rows, transverse rows of setae on distal half, forming brush; dactylus slender, about 0.44 propodus length. Abdomen: posteroventral margins of pleura of fourth and fifth somites angled rather than rounded; sixth with triangular articulated plate adjacent to base of uropod; telson longer than sixth, broad, tapering to broadly rounded tip, 2 pairs dorsal spines and 2 pairs at each posterolateral angle; outer margin of outer uropod ending as sharp spine, adjacent to base of stout, movable spine; inner uropod about as long as outer, both exceed telson. *Male* Similar to female except that carapace and abdomen slightly more slender, and pubescence on carapace thicker. Antennular peduncle with second segment usually distinctly longer than that of females of comparable size. Chelae usually longer than carapace, with same range of variation as females but often somewhat wider, stouter, as are walking legs.

Color Living animal transparent, except for chromatophores in distinct pattern. Color consists of small red chromatophores usually surrounded by dark blue spots. Pigmented areas of carapace are 2 broad bands on the dorsal part separated by thin middorsal line, unpigmented except between eyes. Two colored patches on the carapace at base of antennae. In female, green eggs in ovary may show through shell. Abdomen also pigmented dorsally and middorsally but deeply colored in band posteriorly at joints. Lateral part of sixth abdominal somite often pigmented as is telson, which, however, has light streak. Uropods mainly red but setae creamy white. Fine band of color near anterior dorsal margin of first somite. Eyestalk, antennule, and antenna heavily pigmented, with flagella reddish. Third maxilliped has scattered spots. Cheliped (pereiopod I) well colored, mainly red, but tips of chelae clear. All pereiopods except I have scattered branching chromatophores. Color ends in straight line midlaterally and ventral parts are quite transparent. By day, when red chromatophores expanded, shrimp is reddish or purplish; by night is distinctly blue. One specimen, after preservation, turned uniform pale green (111). In Alaska, color is recorded as "light green" (219).

Distinctions Separated from *B. setosus*, which also has chelae inverted with dactyli on the lower side, and anterior dorsal margin of carapace projected to shade the eyes, by having dactyli of pereiopods III–V slender and simple; chela of pereiopod I with fingers not longer than rest of propodus; chela of this pereiopod about third to half as wide as long.

Maximum lengths Males: carapace 13.0 mm, total about 35 mm; females: carapace 12.5 mm, total about 33 mm.

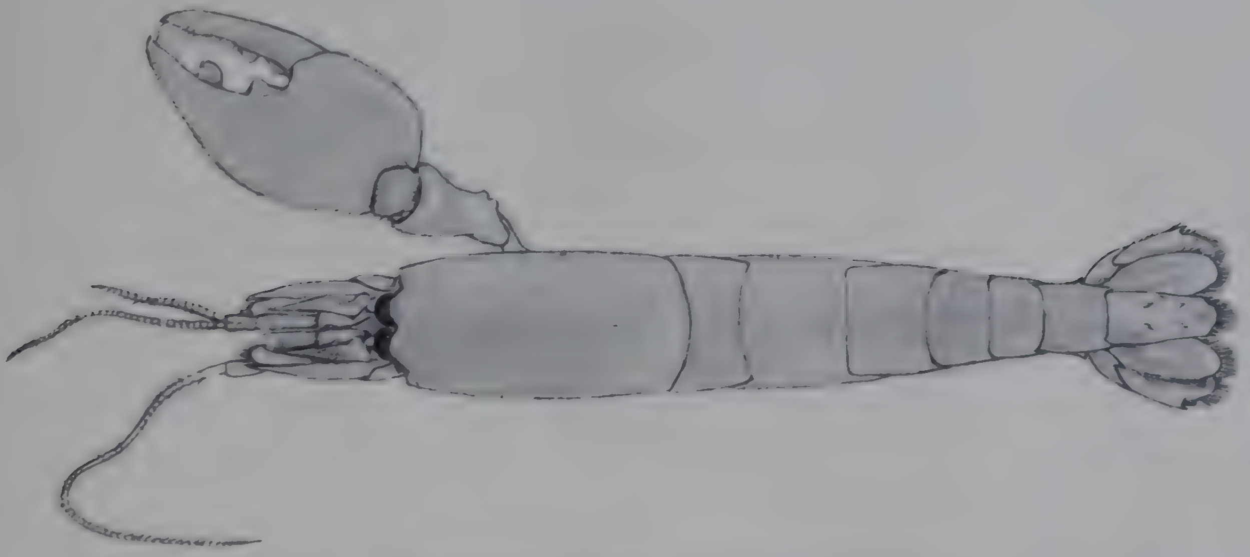
Range Sitka, AK, to Newport Harbor, CA; intertidal (111).

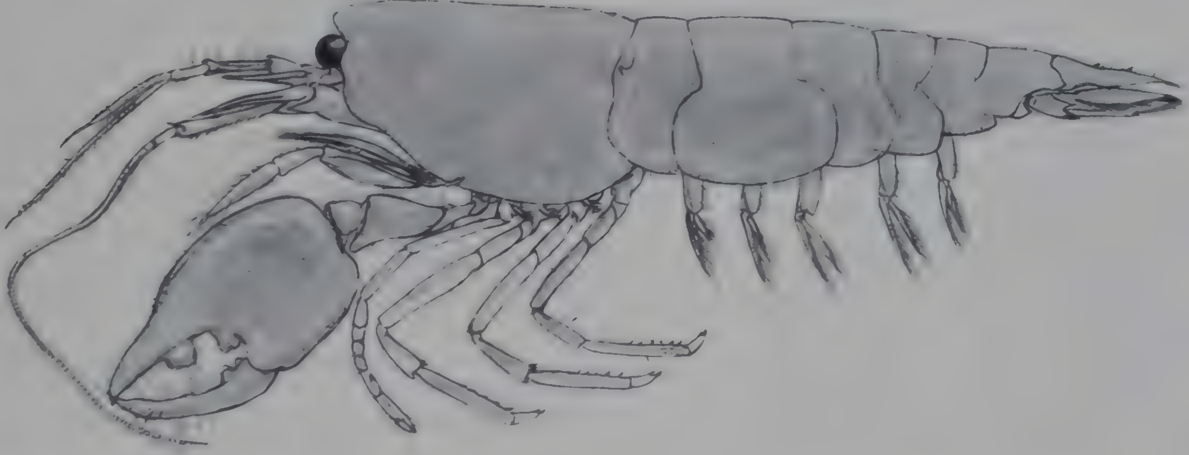
Apparently, the first record in British Columbia waters was that of an individual taken from the stomach of a C-O sole (*Pleuronichthys coenosus* Girard, 1854) caught in Departure Bay, July 9, 1934 (111).

Biology and economics This species is partly free living under logs, boulders, shells, in tide pools; and partly commensal in the burrows of the mud shrimp, *Upogebia pugettensis* (Dana, 1852), and the ghost shrimp, *Callianassa californiensis* Dana, 1854. All known occurrences in the province are from Vancouver Island shores. The question of whether it is really rare or rarely found remains unanswered. It may be that the shrimp eludes collectors because it is very agile, inclined to remain motionless for a while, and then to move very quickly; and even in clear water, its protective coloration and transparency makes the shrimp difficult to see (111). Ovigerous females (smallest, 5.5 mm carapace length) were found in the field, June to September, and in the laboratory, December to July (111).

FUZZY HOODED SHRIMP

Betaeus setosus Hart, 1964





Description *Female* Body deep, little compressed. Shell thin, mainly smooth, scattered short setae on carapace. Carapace: dorsal frontal margin deeply indented medially, slightly depressed, produced laterally to form "blister" over each eye; lateral frontal margin curved smoothly; posterolateral margin distinctly notched adjacent to cardiac region. Eye large, round, sharp spine on stout stalk. Antennule: peduncle long, second segment flattened, about 1¾ length of first and third; stylocerite long, acute tip, extending past middle of second segment; inner flagellum, about as long as carapace, outer, half as long, setiferous. Antenna: scale longer than telson, narrow, large spine longer than lamina, separated from lamina for almost half its length; basicerite, upper lateral lobe, lower strong spine; peduncle long; flagellum twice carapace length, flattened proximally. Third maxilliped: long, stout; proximal segment broad, flattened proximally, twisted, penultimate segment about half length of distal, latter setiferous; exopod; epipod. Pereiopods: I less than twice carapace length, very stout, both sides normally similar in shape, and subequal in size; merus shorter than chela, stout, triangular, expanded distally, broad oblique groove on inner surface accommodating pereiopod II; carpus short, cup shaped; chela inverted, as long as carapace, half or more in width, greatly compressed: fixed finger, upper proximal part thin, sharp, twice as wide there as dactylus; dactylus longer than rest of propodus; inner margins, tips of fingers, and dorsal part of fixed finger setose; left chela, large tooth medially on fixed finger, wide gape, smaller intermeshing teeth; chela at times with small gape, but most small, flat teeth on fingers intermeshing; tips of fingers of both chelae crossed; chelae covered with fine, short setae; epipod; II about ¾ length of I, slender; carpus. 5 segments; chelate; epipod; III longer than II, stouter; merus inflated, 1 spine; carpus, 2 distal spinules; propodus, 8–10 spinules, 1 or 2 rows; dactylus moderately stout, about 0.3 propodus length, bifid; epipod; IV slightly shorter than III, as stout; merus, 1 spine; carpus, 2 distal spinules; propodus; 8–10 spinules, 1 or 2 rows; dactylus moderately stout, about 0.33 propodus length, bifid; epipod; V shorter than IV, more slender; merus, 0 spine; propodus, about 8 spinules, 1 or 2 rows, transverse bands of setae form brush on distal third; dactylus moderately stout, about 0.3 propodus length, bifid. Abdomen: posteroventral margins of fourth and fifth angled, rather than rounded, latter with blunt spine; sixth with triangular articulated plate adjacent to base of uropod; telson longer than sixth, broad, tapering to broadly rounded tip, 2 pairs dorsal spines, and 2 pairs at each posterolateral angle; distal angle of outer margin of proximal part of outer uropod with sharp spine, adjacent to stout, movable spine; uropods about equal, both longer than telson. *Male* Similar to female except abdomen narrower; chelipeds larger in proportion, chelae longer than carapace; and antennular peduncle proportionately longer.

Color Living specimens in British Columbia a uniform white or yellow in the light but pink or orange in the dark. Color change due to presence of tiny red chromatophores, which expand in dark, thickly dotted over dorsal half of shrimp (except over eyes) and on chelae. Some specimens have pale blue tinge on chelae and flagella. Cast shell pale blue dorsally, with yellow setae on lamina of antennal scale, and on tail fan. Tips of dactyli of pereiopods yellow (111).

Distinctions Distinguished from the northern hooded shrimp by having the dactyli of pereiopods III–V moderately stout, and tips bifid; the chela of pereiopod I with fingers longer than rest of propodus; chela of this pereiopod more than half as wide as long; median dorsal frontal margin of carapace deeply notched.

Maximum lengths Males: carapace 7.0 mm, total about 20 mm; females: carapace 8.5 mm, total about 25 mm.

Range Hecate Strait, B.C., to Morrow Bay, CA; intertidal to 18 m (111).

It is presumed that *B. setosus* was first collected in Canadian waters in Esperanza Inlet, on High Island, and off Tatchu Point, June 28, 1934 (111).

Biology and economics In British Columbia, this shrimp has been caught in a trawl at 18 m, in tide pools, and with the anomuran crab, *Pachycheles rudis,* Stimpson, 1859, in cavities under the holdfasts of kelp (usually *Pterygophora californica*) or eelgrass roots (*Phyllospadix* sp.), and often in pairs. Elsewhere in its range, and at times listed as the southern species *B. harfordi, B. setosus* has been found under rocks, among marine plants, and on pilings (111). Ovigerous females (smallest, 4.8 mm carapace length) occurred on the west coast of Vancouver Island, May to August, and in California, February to June (111). Two ovigerous females, 5.3 and 6.0 mm carapace length, were collected intertidally by D. B. Quayle in Grant Bay, July 21, 1959. *B. setosus* has not been found in the Strait of Georgia, or in other inside coastal waters.

Family HIPPOLYTIDAE Bate, 1888

Rostrum long or short, of various shapes, toothed, and laterally compressed. Supraorbital spine present or absent. Mandible with or without incisor process and palp. Third maxilliped with or without exopod. First pereiopod chelate, moderately stout, stouter and shorter than other pereiopods. Second pereiopod chelate, slender, with segmented carpus. In all British

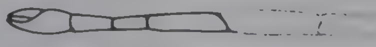
Columbia genera of the family, outer margin of outer uropod or exopod ends in two spines, outer spine immovable, inner movable.

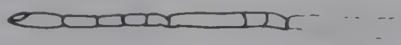
It is one of the largest families of shrimps, and certainly the largest in the North Pacific Ocean, with respect to number of species. These shrimps are small to moderate in size. They inhabit all oceans, mainly in the littoral or continental shelf zones but some species occur in deep water. The Russian specialist, L. G. Vinogradov, named hippolytid shrimps "obyknovennye krevetki" or ordinary shrimps (266).

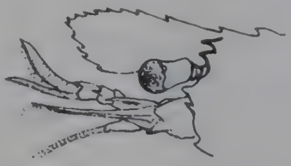
The large, unwieldy, genus *Spirontocaris,* as described in papers (217, 219, 232), was separated more recently (129) into *Spirontocaris* s.s., *Lebbeus, Eualus, Heptacarpus,* and two other genera not occurring off the west coast of North America.

There are five genera in British Columbia waters.

Key to genera of Family HIPPOLYTIDAE

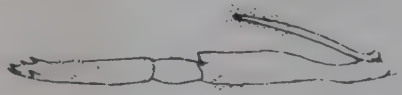
1 Carpus of second pereiopod with 3 segments;  branchiostegal spine present .... *Hippolyte* (p. 155)

Carpus of second pereiopod with 7 segments;  branchiostegal spine absent 2



2 Supraorbital spines present on carapace 3

Supraorbital spines absent 4



3 Two or more supraorbital spines; third maxilliped with exopod .... *Spirontocaris* (p. 157)

One supraorbital spine; no exopod on third maxilliped .... *Lebbeus* (p. 176)

4 Exopod on third maxilliped .... *Eualus* (p. 188)

No exopod on third maxilliped .... *Heptacarpus* (p. 205)

Genus *Hippolyte* Leach, 1815

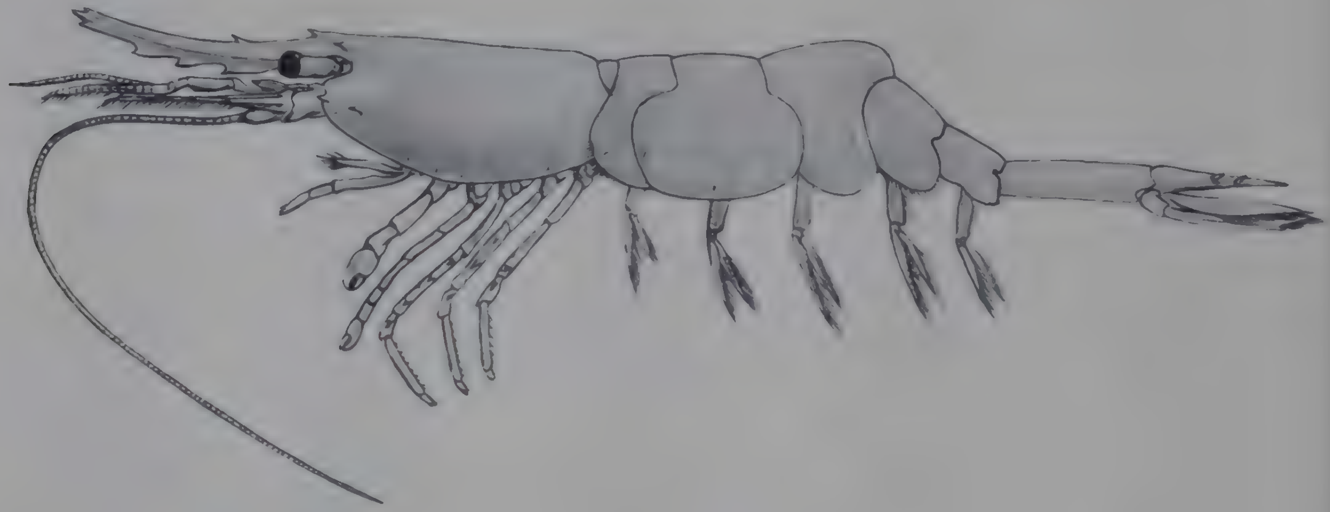
Rostrum conspicuous and armed. Carapace with supraorbital and branchiostegal spines. Mandible with incisor process but without palp. Eyes medium size. Third maxilliped with exopod but without epipod. Carpus of second pereiopod with three segments. Third to fifth pereiopods of males generally prehensile. Telson with two pairs of dorsolateral spines.

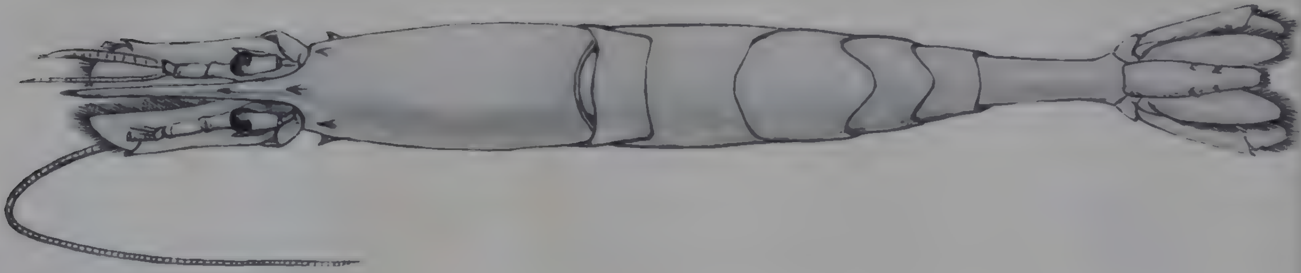
Members of this genus are generally small shrimps. As most species live on vegetation of the littoral zone or on floating weeds *(Sargassum)* they are termed "grass shrimps." In Greek mythology, Hippolyta was queen of the Amazons.

One species occurs in British Columbia waters.

GRASS SHRIMP

Hippolyte clarki Chace, 1951





Description *Female* Body slender, and moderately compressed. Shell thin, surface smooth. Rostrum moderately long, 1.2–1.4 carapace length, slightly arched over eyes, rest ascending, $\frac{2-5}{1-5}$, tip normally trifid. Carapace spines: supraorbital strong; suborbital obtuse; antennal moderate; branchiostegal strong, well behind anterior margin. Eye moderate, cornea well developed. Antennule: peduncle long, third segment about third length of second; stylocerite short, tip acute; inner flagellum longer than outer, both reach or exceed tip of rostrum. Antenna: scale longer than sixth abdominal segment, both margins slightly concave, lamella greatly exceeds spine; basicerite, upper lateral lobe and lower strong spine; peduncle short; flagellum about body length. Third maxilliped: short, slender; exopod. Pereiopods: I longer than third maxilliped, stout; chelate; II longer than I, slender; carpus, 3 segments, proximal longer than other 2; chelate; III longer than II, slender; merus, 2–5 spines; carpus, 1 spine; propodus, 10–14 spinules, 2 rows; dactylus flattened, about 0.2 propodus length, 6–8 spinules around tip, 14–16 spinules, 2 rows, on distal part of flexor margin; IV shorter than III, slender; merus, 2–5 spines; carpus, 1 spine; propodus and dactylus as in III; V as long as IV, slender; merus, 1–4 spines; carpus, 1 spine; propodus and dactylus as in III. Abdomen: dorsal posterior margin of third somite produced moderately; posterolateral margins of fourth and fifth recessed deeply at articular knobs; sixth almost twice length of fifth, slender, posteroventral angle obtuse; telson shorter than sixth, moderately wide, tapering to rounded tip, 2 pairs dorsolateral spines; both uropods longer than telson, outer slightly longer than inner. *Male* Differs from female mainly as rostrum more slender, shorter, 0.8–1.1 carapace length, more arched over eyes, less pronounced trifid tip; eye extends forward more; third maxilliped and pereiopods longer; pereiopods III–V; propodi each wide and flat in distal half, flexor margin with 7 pairs large spinules; dactyli, each slender, about 0.4 propodus length, about 14 spines on flexor margin, 5 or 6 pairs spinules on distal part of extensor margin, tip acute (Fig. 4B).

Color Green over most of body, including rostrum, basal segments of antennule and antenna, and pleopods; distal parts of both uropods pinkish; pereiopods mainly translucent; chelae of pereiopods I and II, dactyli and propodi of IV and V, antennal scale, and cornea of eye pinkish (Plate 3A).

Distinctions *H. clarki* is the only local shrimp having the carpus of pereiopod II with 3 segments, as well as both supraorbital and branchiostegal spines.

Maximum lengths Males: carapace 3.2 mm, total about 18 mm; females: carapace 6.0 mm (70), total 31 mm.

Range Sheep Bay, AK (250, 43) to Puget Sound (70); Santa Catalina Island, CA (290); intertidal to 30.5 m (290).

First taken in British Columbia waters in Barkley Sound, by shore collecting from *Albatross,* Sept. 27, 1888 (219).

Biology and economics This shrimp occurs on eelgrass where it clings lengthwise on the blade, and between fronds of kelp *(Nereocystis)* (109). Shore collections were made at 6 localities in southeastern Alaska and Prince William Sound, where temperatures and salinities were 6.0–14.5°C and 27.0–30.8‰, respectively (250, 43). In Departure Bay, the species has been caught along with *Heptacarpus tenuissimus* and *H. brevirostris.* Ovigerous females are present from May to October. The smallest ovigerous female known is 3.0 mm, carapace length (70). The first stage larva was described as *Hippolyte californiensis,* and larval characters of *Hippolyte* were compared with those of other hippolytid genera (197).

Genus *Spirontocaris* Bate, 1888

Rostrum conspicuous and armed. Two or more supraorbital spines. Mandible with incisor process and palp of two segments. Eye well developed, with or without prominent process on inner basal part of stalk. Third maxilliped with exopod and epipod. Epipods present on one to three pereiopods. Carpus of second pereiopod with seven segments.

The definition of the genus (115) has been modified to permit the inclusion of two eastern Pacific species, *Spirontocaris holmesi* and *S. sica,* which both lack the prominent process on the inner surface of the eyestalk. Dr K. Hayashi kindly confirmed the absence of the process on the eyestalk of *S. holmesi.* He was the first known author to describe the process (115).

In addition to lacking the eyestalk process, *S. holmesi* and *S. sica* have attributes in common that appear to set them apart from other species of the genus. These are slender body; thin shell; slender pereiopods; dactyli of the third to fifth pereiopods elongate, slender, with acute tips; epipods on the first, or first and second pereiopods; rostrum bladelike, with a styliform distal projection; and, absence of a ventral spine on the fourth abdominal pleuron. Other species of *Spirontocaris,* with some exceptions described later, apparently are characterized by having a stout body; a thick shell; relatively stout pereiopods; dactyli of the last three pereiopods, short, stout to moderately stout, with bifid tips; epipods on the first three pereiopods; a rostrum mainly deep and leaflike, without the distal styliform projection; and a ventral spine on the fourth pleuron. This generalization, probably oversimplified, was based on a consideration of the British Columbia species, *S. prionota, S. truncata, S. ochotensis,* and *S. arcuata,* and literature descriptions of species elsewhere.

S. lamellicornis was excluded from the second or main group of species because the dactyli of the third to fifth pereiopods are elongate, slender, with acute tips. Another exception is *S. snyderi.* Although it has the eyestalk process and moderately stout dactyli with bifid tips, the species is slender with a thin shell, relatively slender pereiopods, and epipods on only the first and second pereiopods. Other exceptions may be found among species unfamiliar to the present author.

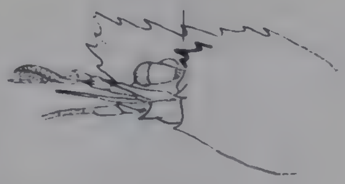
In his monograph on the Hippolytidae, Holthuis (129) constructed a key for *Spirontocaris,* using characters such as the number of supraorbital spines, number of epipods on pereiopods; shape of abdominal pleura; position of dorsal spines relative to the posterior margin of the carapace, and shape of the dorsal posterior margin of the third abdominal somite. Species other than *S. prionota, S. pectinifera, S. lamellicornis, S. sica, S. holmesi,* and *S. snyderi* fell into three groups, but Holthuis did not assign them to separate taxonomic categories. The three groups have been termed more recently as the *phippsi, spinus,* and *lilljeborgii* groups (115). One character, the position of dorsal spines on the carapace, appeared in keys written by others (105, 244). Three supraorbital spines on *S. truncata* (p. 163) remove it from the *spinus* group.

S. holmesi and *S. sica* stand apart from other species of the genus to the extent that both species lack an eyestalk process and a ventral spine on the fourth pleuron, and have a styliform distal projection on the rostrum. In addition, *S. sica* at least appears to have a partial pelagic existence (p. 168), in contrast to the likely predominantly demersal life of its congeners. However, until other important morphological differences are observed, perhaps in larval stages, the present author does not favor assigning *S. holmesi* and *S. sica* to a separate subgenus.

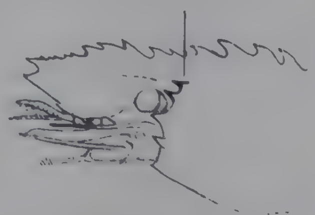
In size, species of the genus *Spirontocaris* are small to medium. The 19 known species (115) are confined to the North Pacific Ocean, including the Okhotsk Sea, Sea of Japan, and Bering Sea; the North Atlantic Ocean; and the Arctic Ocean, including the Chukchi Sea. The biology of two British species is known (7).

Each of the eight recorded British Columbia species is named here "bladed shrimp."

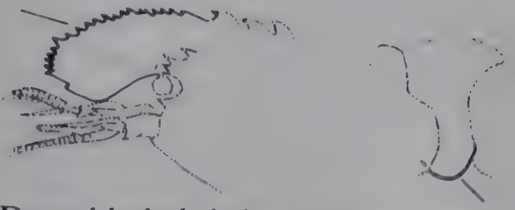
Key to species of genus *Spirontocaris*



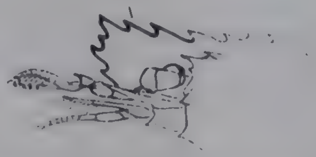
1 Carapace with 3 or 4 supraorbital spines (on small specimens, anterior of 3 obscured) 2



Carapace with 2 supraorbital spines 3

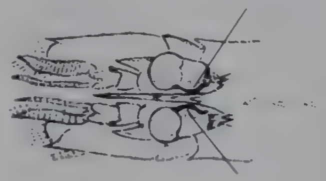


2 Deep rostrum, 10–26 mainly small dorsal spines (excluding 3 and 4 on carapace); ventral margin of third pleuron acute or bluntly pointed .... Deep-bladed shrimp, *S. prionota* (p. 161)

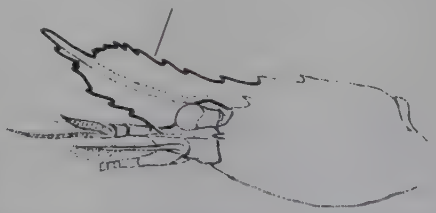


Rostrum moderate depth, 1–3 large dorsal spines (anterior normally bifid), truncate; pleuron of third somite broadly rounded .... Blunt-bladed shrimp, *S. truncata* (p. 163)

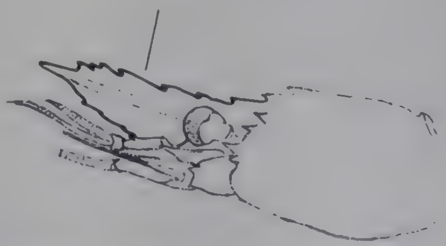
3 Epipods on first, or first and second pereiopods; process on inner surface of eyestalk absent 4



Epipods on first and second pereiopods, or on first to third pereiopods; process present on inner surface of eyestalk 5

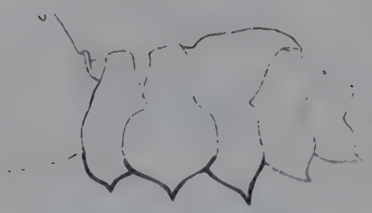


4 Distal projection of rostrum with 1 ventral spine; epipods on first and second pereiopods .... Slender-bladed shrimp, *S. holmesi* (p. 165)



Distal projection of rostrum without ventral spine; epipod on pereiopod I only .... Dagger-bladed shrimp, *S. sica* (p. 167)

5 Pleura of first to third somites ventrally acute, or bluntly pointed (on specimens about 10 mm carapace length and larger); dactyli of third to fifth pereiopods long, slender, with acute tips .... Dana's bladed shrimp, *S. lamellicornis* (p. 169)



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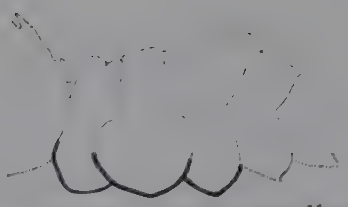
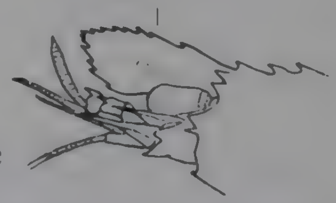


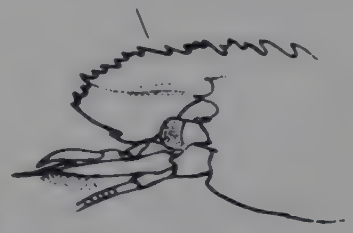
Pleura of first to third somites more or less broadly rounded ventrally; dactyli of third to fifth pereiopods short, stout or moderately stout, tips bifid 6

6 Body slender to moderately stout, shell thin; epipods on first and second pereiopods .... Snyder's bladed shrimp, *S. snyderi* (p. 171)

Body moderately stout to stout, shell thick; epipods on first to third pereiopods 7



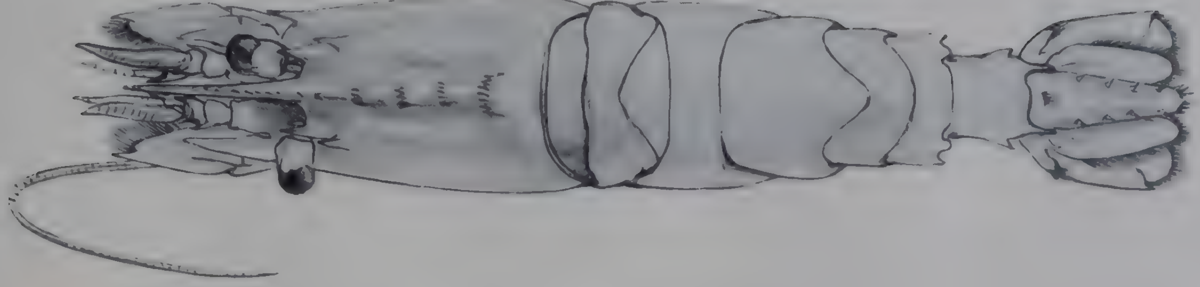
7 Rostrum more or less ovoid: posterior dorsal spine on carapace located near middle of carapace .... Oval bladed shrimp. *S. ochotensis* (p. 173)

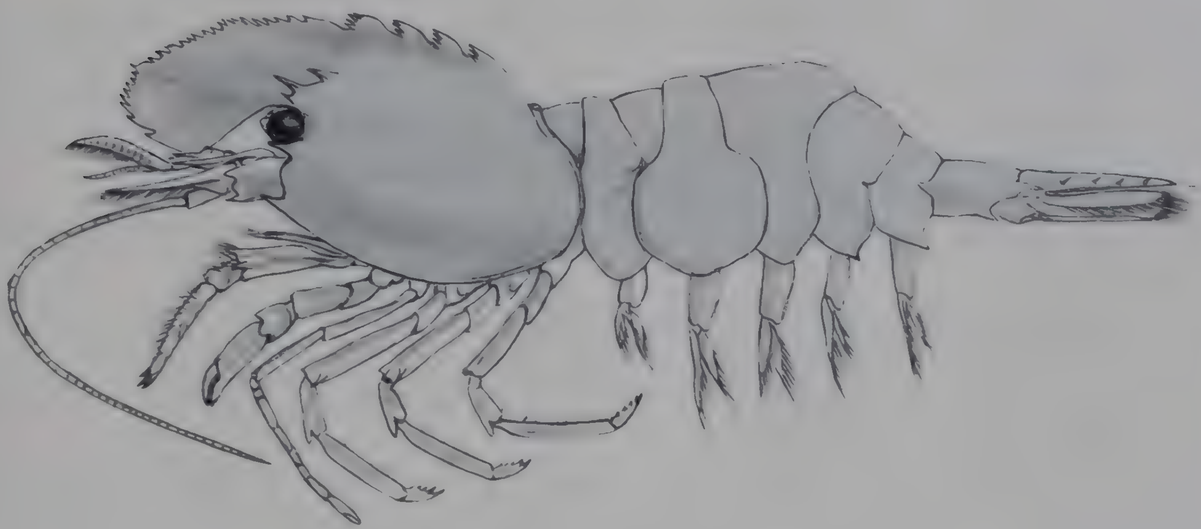


Rostrum with lower limb broader than upper; posterior dorsal spine of carapace located on posterior third of carapace .... Rathbun's bladed shrimp, *S. arcuata* (p. 175)

DEEP-BLADED SHRIMP

Spirontocaris prionota (Stimpson, 1864)





Description Stout, little compressed. Shell thick, surface of abdomen sparsely pubescent. Rostrum moderately long, 0.6–1.0 carapace length, arising from broad base, outer part as deep blade, margin of lower limb projected distally, dorsal margin rising back to line of carapace spines, midrib horizontal or ascending slightly, not usually projected as extremity, ♂ $\frac{10-15}{6-7}$, ♀ $\frac{12-26}{3-8}$, excluding 3 and 4 on carapace, anterior or dorsal margins of each armed with 3–7 minute spines. Carapace spines: 3 or 4 supraorbitals, 2 upper larger ones widely separated; suborbital moderate, pointed; antennal strong; pterygostomian strong. Eye moderate, cornea well developed, stalk with pointed process on inner margin. Antennule: peduncle moderately long, third segment much smaller than second, each with dorsal distal spine, another spine at base of inner flagellum; stylocerite long, lamellar, tip blunt; flagella about equal length, overreaching antennal scale, outer setiferous. Antenna: scale shorter than telson, moderately wide, tapers abruptly distally, spine arising from wide thickened portion, and exceeds lamella; basicerite, 2 or 3 lateral lobes or spines; peduncle moderately long; flagellum shorter than body. Third maxilliped: moderately long, stout; setiferous; 1 or 2 distal spines on proximal segment; exopod; epipod. Pereiopods: I shorter than third maxilliped, stouter; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III shorter than II, stouter; merus, 1 or 2 spines; propodus, about 16 spinules, 1 or 2 rows; dactylus stout, about 0.40 propodus length, 5 spines, bifid; epipod; IV slightly shorter than III, as stout; merus, 0–2 spines; propodus, about 16 spinules, 1 or 2 rows; dactylus stout, about 0.4 propodus length, 4 or 5 spines, bifid; V about as long as IV, as stout; merus, 0 or 1 spine; propodus, about 12 spinules, 1 or 2 rows; dactylus stout, about 0.34 propodus length, 4 or 5 spines, bifid. Abdomen: third somite with dorsal posterior margin produced moderately, and ventral margin of pleuron pointed bluntly and angled laterally in males, rounded in females; pleuron of fourth with moderate to strong ventral spine; posterolateral margin of fifth with moderate lateral spread below articular knob, strong spine; sixth broad, slightly depressed, with strong posteroventral spine slightly flared; telson moderately wide, tapering to acute tip, dorsal sulcus, 4 pairs dorsolateral spines; inner uropod narrower and slightly longer than outer, both shorter than telson.

Color Descriptions provided by Hart (109). Male found among eelgrass at Gonzales Point had sides of carapace as well as rostrum, antennal scale, third maxilliped, chelipeds (pereiopods I and II), basal segments of pereiopods III–V, and anterior part of abdomen finely spotted with red; blue streaks on posterior middorsal margin of carapace and proximal part of abdomen, on body below pterygostomian spine, and on base of pereiopod I and ischia of pereiopods III and IV. Female from shallow water in False Narrows similar to male except colors less intense; another female caught in Departure Bay at 18 m had carapace and inner pair of uropods tawny olive, rest of specimen rufous.

Distinctions Separated from other bladed shrimps, with epipods on pereiopods I–III, by deep-bladed rostrum armed with many uneven dorsal spines, 10–26 depending on sex; 3 or 4 large dorsal spines on carapace, each with 3–7 minute spines on dorsal or anterior margin; and presence of 3 or 4 supraorbital spines. Another minor character is the lateral expansion of posterolateral margin of fifth abdominal somite, visible in dorsal view.

Maximum lengths Males: carapace 3.8 mm, total 19 mm; females: carapace 6.8 mm, total 28 mm.

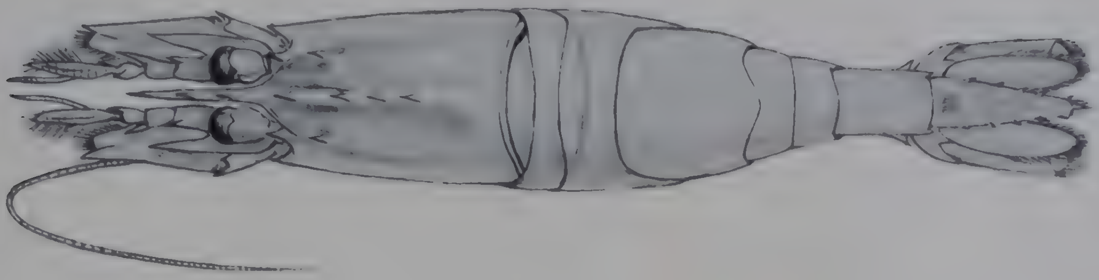
Range Nunivak Island and Bering Island, Bering Sea, to Monterey, CA (219); Okhotsk Sea; Sea of Japan, to Peter the Great Bay, and Mutsu Bay; 4–163 m (115).

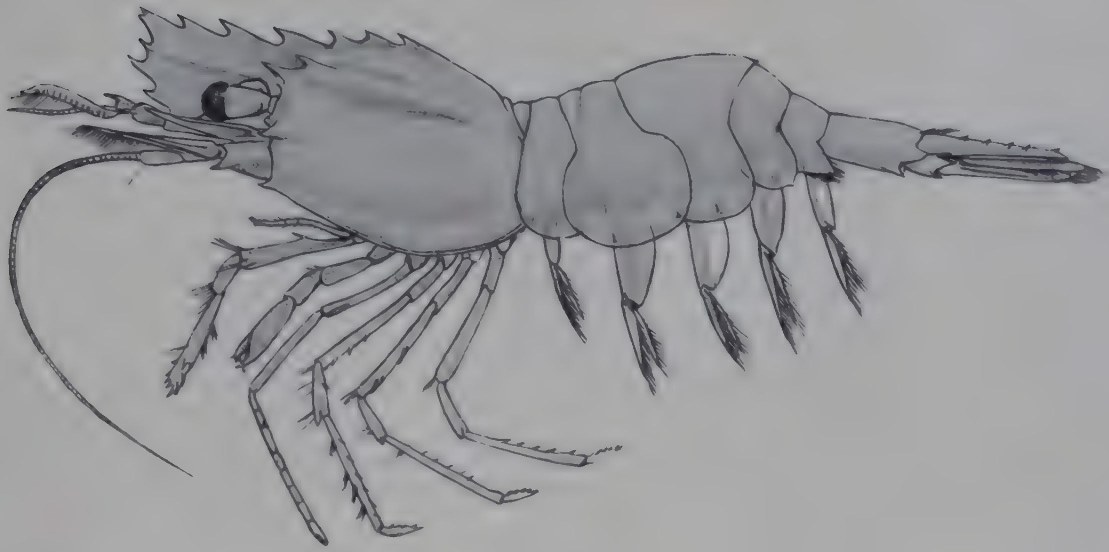
The species was first recorded in Canadian waters by Taylor (258), who dredged it in Burrard Inlet, at an unknown depth, June 29, 1906.

Biology and economics *S. prionota* is by no means common in local waters. Fifteen occurrences (about 20 specimens) from 1906 to the present are known, 11 from the sublittoral zone to 73 m, and the rest from tidal beaches. An ovigerous female, 4.3 mm carapace length, was caught in Cypress Bay at 37 m, Apr. 17, 1961, and another 6.4 mm, in Naden Harbour at 16 m, Apr. 17, 1964. This shrimp is infested by the abdominal isopod, *Hemiarthrus abdominalis* (89, 100).

BLUNT BLADED SHRIMP

Spirontocaris truncata Rathbun, 1902





Description Body stout, compressed. Shell thick, surface smooth. Rostrum moderately long, 0.6–0.7 carapace length, arising from broad base, outer part as broad, truncated blade, lower limb broader, midrib extended as slender spine, but not to extremity, $\frac{7-9}{3-4}$. Carapace spines; 3 supraorbitals, 2 larger widely separated, anterior of these 2 stronger, most anterior weak, or obsolescent; suborbital moderate, pointed; antennal strong with supporting carina; ptyergostomian strong. Eye moderate, cornea well developed, stalk with prominent process on inner margin. Antennule: peduncle long, second and third segments about equal, dorsal distal spine on each; stylocerite, long, knifelike; inner flagellum longer than outer, latter setiferous, both exceed antennal scale. Antenna: scale slightly shorter than telson, spine arising from wide outer thickened portion and exceeds lamella; basicerite with upper lateral lobe and lower strong spine; peduncle moderately long; flagellum shorter than body. Third maxilliped: moderately long, moderately stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III as long as II, slightly stouter; merus, 2 or 3 spines; propodus, 13–15 spinules, in 1 or 2 rows; dactylus moderately stout, about 0.28 propodus length, 5 or 6 spines, bifid; epipod; IV longer than III, as slender; merus, 2 spines; propodus, about 12 spinules, in 1 or 2 rows; dactylus moderately stout, about 0.3 propodus length, 5 or 6 spines, bifid; V shorter than IV, as slender; merus, 0 spine; propodus, about 9 spinules, in 1 or 2 rows; dactylus moderately stout, about 0.33 propodus length, 5 or 6 spines, bifid. Abdomen: transverse dorsal sulcus on second somite; pleuron of fourth with weak ventral spine; strong posterolateral spine on fifth; sixth shorter than telson, wide and depressed;

with strong posteroventral spine; telson moderately wide, tapering to acute tip, 4 or 5 pairs dorsolateral spines; inner uropod longer than outer, and exceeding telson.

Color Most of abdomen milkish, with faint red dots on dorsal surface of third somite. Dark red dots on sixth somite over orange-yellow base form wide band over telson and uropods; on protopodites of pleopods. Carapace yellow-orange base, with red-orange to deep red dots over most of surface; posterior dorsal spines on carapace dark brown. Light red dots on antennular peduncle, basicerite of antenna, and upper and lower limbs of rostrum. Third maxilliped, closely spaced red dots, distal segment yellowish. Pereiopods: I, closely spaced red dots; II, almost colorless; III–V, red dots sparse (Plate 3C).

Distinctions Separated from other bladed shrimps mainly by rostrum abruptly truncated short of the end of antennular peduncle; relatively few large spines, 4 evenly spaced on dorsal surface of carapace, with dorsal extremity bifid; midrib extended as slender spine, not reaching the extremity of blade. *S. truncata* has 3 supraorbital spines: 2 are large, and widely separated, the smallest and most anterior spine appears to originate from base of, or branch more distally from, lower of the 2 large supraorbitals. A minor character, yet consistently present on the 6 specimens examined, is the transverse dorsal sulcus on second abdominal somite.

Maximum lengths Males: carapace length unavailable, total 14 mm (219); females: carapace 4.7 mm, total 20 mm.

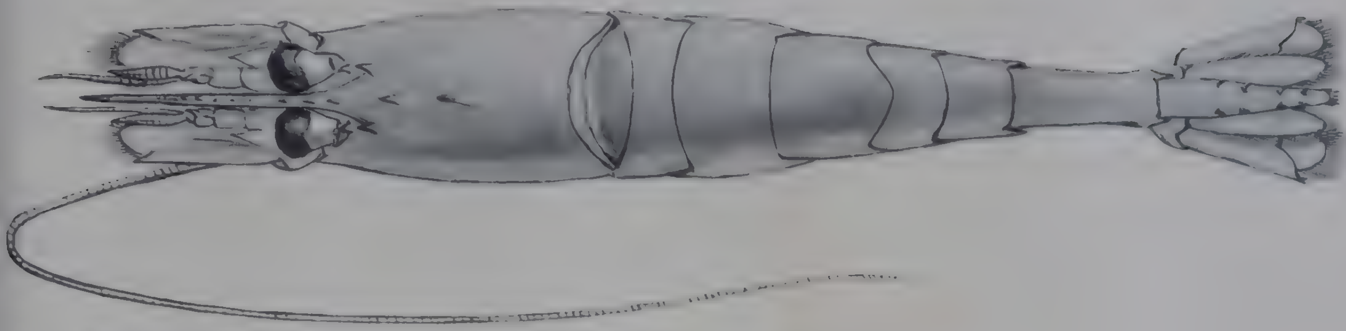
Range Gabriola Island, Strait of Georgia (55) to Hecata Bank, OR (219); 44–92 m.

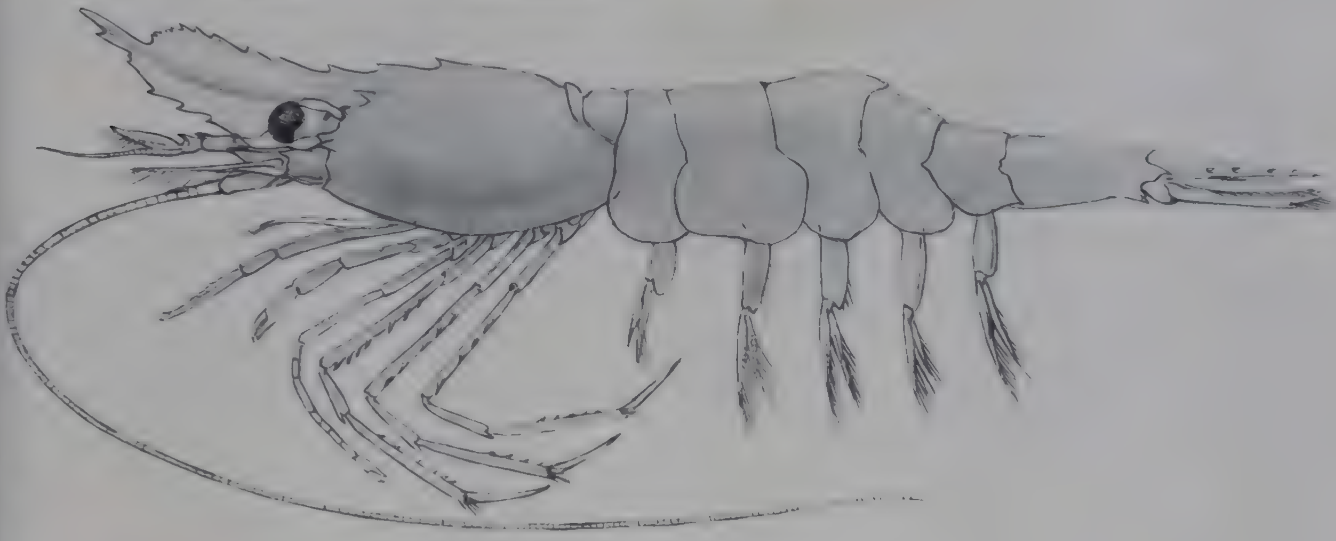
The species was first recorded from Canadian waters by the author (55), who collected a specimen north of Gabriola Island at 92 m, Nov. 7, 1961.

Biology and economics The blunt bladed shrimp was found off Gabriola Island, associated with the elegant coastal shrimp *(Heptacarpus decorus)* and the doll eualid *(Eualus pusiolus)*, in the hollow tubular sponge, *Rhabdocalyptus dawsoni.* Six females, 2.3–4.7 mm carapace length, have been collected: 3, including the first recorded specimen, from the station off Gabriola Island; and the rest from a locality near Hudson Rock at 44–48 m. A male has yet to be collected in local waters.

SLENDER BLADED SHRIMP

Spirontocaris holmesi Holthuis, 1947





Description Body slender, compressed. Shell thin, surface smooth. Rostrum moderately long, 1.0–1.5 carapace length, constricted at base, median section as broad blade, lower limb broader, rounded, and distal portion as slender, ascending, styliform process. $\frac{8-16}{3-7}$, solitary distal ventral spine, tip acute. Carapace spines: 2 supraorbitals widely separated, upper spine stronger; suborbital moderate, pointed; antennal moderate; pterygostomian weak, or obsolescent. Eye large, cornea well developed. Antennule: peduncle moderately long, third segment shorter than second, each with dorsal distal spine; stylocerite moderately long, inner flagellum shorter than rostrum, outer extending beyond antennal scale slightly. Antenna: scale shorter than telson, lamella exceeds spine somewhat; basicerite with 2 weak lateral spines; peduncle long; flagellum longer than body. Third maxilliped: moderately long, stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, a little stouter; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, a little stouter; merus, 6 or 7 spines; propodus, 4–8 spinules, distal fringe of setae; dactylus slender, about 0.6 propodus length, tip acute; IV about as long as III, as slender; merus, 5–8 spines; propodus, about 4 spinules, distal fringe of setae; dactylus slender, about 0.6 propodus length, tip acute; V shorter than IV, as slender; merus 4 or 5 spines; propodus, 3–6 spinules, distal fringe of setae; dactylus slender, about 0.55 propodus length, tip acute. Abdomen: ventral margin of pleuron of second somite mainly straight or slightly concave; fifth, posterolateral margin widely recessed at articular knob, and with moderate spine; sixth, moderate posteroventral spine, and small lobe above it; telson narrow, tapering to rounded tip, 3 or 4 pairs dorsolateral spines; uropods about same length, reaching to tip of telson.

Color Background of body yellowish wash; carapace, 2 oblique red lines starting in branchial region, meeting wide red bar along ventral margin adjacent to third maxilliped and pereiopods I and II; patches of red posterior to antennal spine, large patch of red dots in gastric and cardiac regions; rostrum mainly transparent with fine red dots on lower limb; antenna, basicerite, and scale with red patches; peduncle and flagellum pinkish; third maxilliped and pereiopods, red spots on milkish base; red blotches on abdomen, mainly on lateral surfaces; faint, fine red speckling on telson and uropods; pleopods with distinctive red lines on basiopodites (Plate 6E).

In December before extrusion of eggs, females had conspicuous green ovary visible in dorsal part of carapace, extending into first and second abdominal somites.

Distinctions Characterized by slender body; bladelike rostrum with styliform projection armed with solitary ventral spine; 2 widely spaced suborbital spines; presence of epipods on pereiopods I and II; mainly straight, or slightly concave, ventral margin of pleuron of second abdominal somite.

Maximum lengths Males: carapace 8.3 mm, total about 44 mm; females: carapace 12.3 mm, total 62 mm.

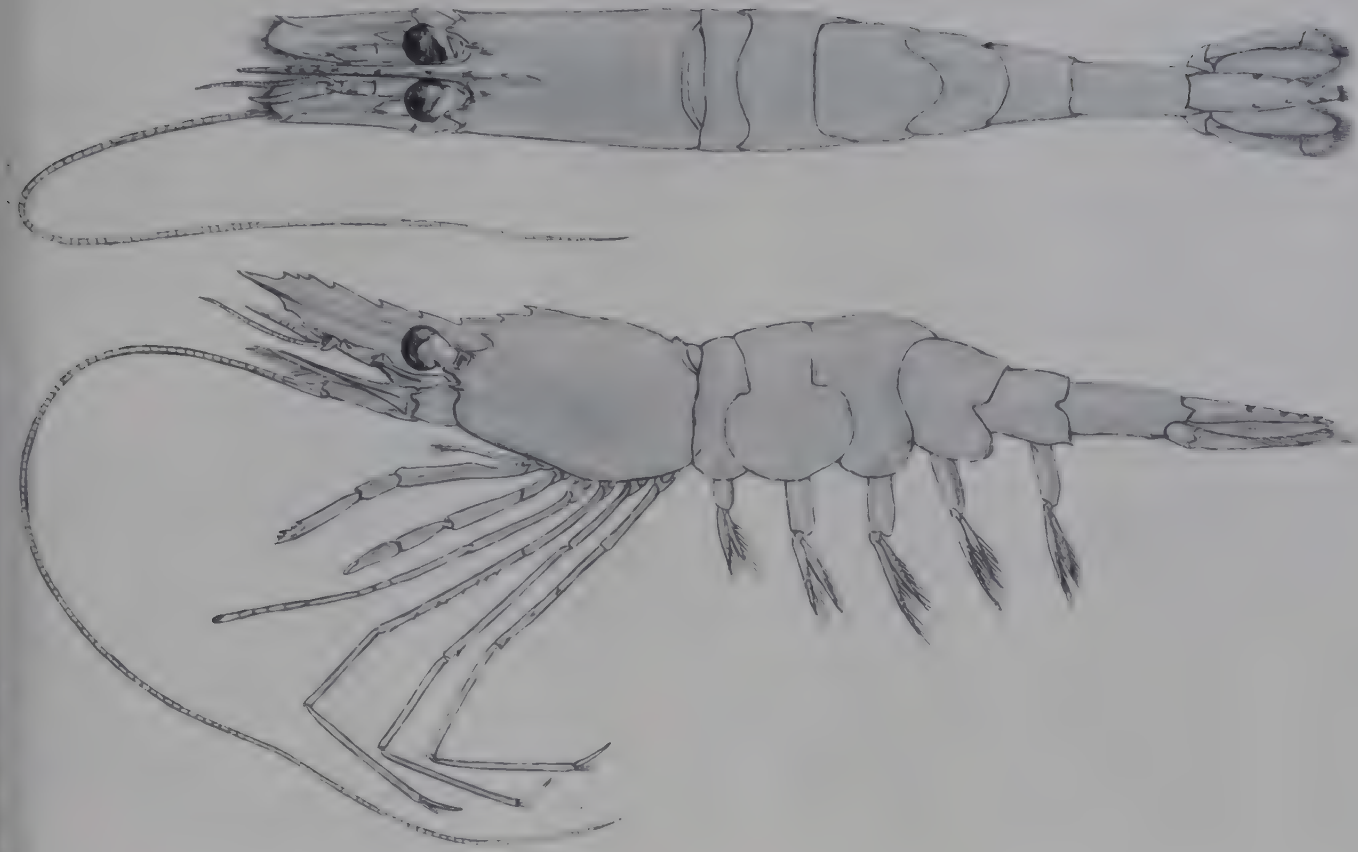
Range Yes Bay, AK (232) to San Diego, CA; 24–386 m (219).

First collected on the British Columbia coast by the *Albatross* off Port San Juan at 212 m, Aug. 27, 1891 (station 3447) (219).

Biology and economics *S. holmesi* almost invariably forms part of the catches of dredge or shrimp trawl hauls made at 70 m and deeper in all coastal areas. Apparently it occurs most abundantly in 90–183 m. Ovigerous females, 9.0–12.0 mm carapace length, were collected during January, March, June, July, September, and October. Three parasites infest this shrimp: 2 isopods, *Bopyroides hippolytes* and *Hemiarthrus abdominalis* (225), and the rhizocephalan, *Sylon hippolytes* (41).

DAGGER BLADED SHRIMP

Spirontocaris sica Rathbun, 1902



Description Body slender, somewhat compressed. Shell thin, surface smooth. Rostrum moderately long, 0.9–1.2 carapace length, constricted at base, median section as broad blade, lower limb broader and tapering sharply, distal portion as slender, ascending, styliform process, $\frac{9-15}{3-8}$, tip acute. Carapace spines: 2 supraorbitals, widely spaced, upper spine stronger; suborbital strong, rounded; antennal moderate with supporting carina; pterygostomian weak or obsolescent. Eye large, cornea well developed. Antennule: peduncle long, third segment half length of second, dorsal distal spine on each; stylocerite moderately long, knifelike; inner flagellum longer than rostrum, outer extending beyond antennal scale slightly. Antenna: scale slightly shorter than telson, lamella exceeds spine somewhat; basicerite, 2 lateral lobes; peduncle moderately long; flagellum longer than body. Third maxilliped: moderately long, moderately stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, a little stouter; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, a little stouter; merus, 5–9 spines; propodus, about 4 spinules, distal fringe of long setae; dactylus slender, about 0.43 propodus length; IV slightly longer than III, as slender; merus, 6–8 spines; propodus, 4–7 spinules, setae as in III; dactylus slender, about 0.36 propodus length; V shorter than IV, as slender; merus, 4–7 spines; propodus, 1–8 spinules, long setae in band around distal end; dactylus slender, about 0.3 propodus length. Abdomen: ventral margin of pleuron of second somite broadly convex; posterolateral margins of fourth and fifth deeply recessed at articular knobs; fifth with weak posterolateral spine; sixth about as long as telson, slender, with moderate posteroventral spine and small lobe above it; telson narrow, tapering to acute tip, 4 pairs dorsolateral spines; uropods about same length, extending to tip of telson.

Color Background of body milkish to dull yellow. Red blotches on carapace. larger specimens have red band along ventral margin, large red area on branchial region; most have pinkish dorsal patch. Rostrum, few red dots on midrib. Pinkish on antennular peduncle and flagella, basicerite, and base of scale of antenna. Fine red spots on lateral surfaces of first to fifth somites of abdomen, to lesser extent dorsally; also on distal lateral surface of sixth somite; telson and uropods pinkish. Protopodites of pleopods pale amber; endopods and exopods pale magenta. Pereiopods almost completely dark red (Plate 7D).

Females, before extrusion of eggs, have dark green ovary, visible in dorsal part of carapace and first and second abdominal somites. Egg mass when first extruded dark brown.

Distinctions Distinguished from other bladed shrimps by slender body; daggerlike rostrum with styliform projection without solitary ventral spine; broadly convex ventral margin of pleuron of second abdominal somite; presence of epipod on third maxilliped and only on pereiopod I.

Maximum lengths Males: carapace 8.0 mm, total 42 mm; females: carapace 13.3 mm, total 65 mm.

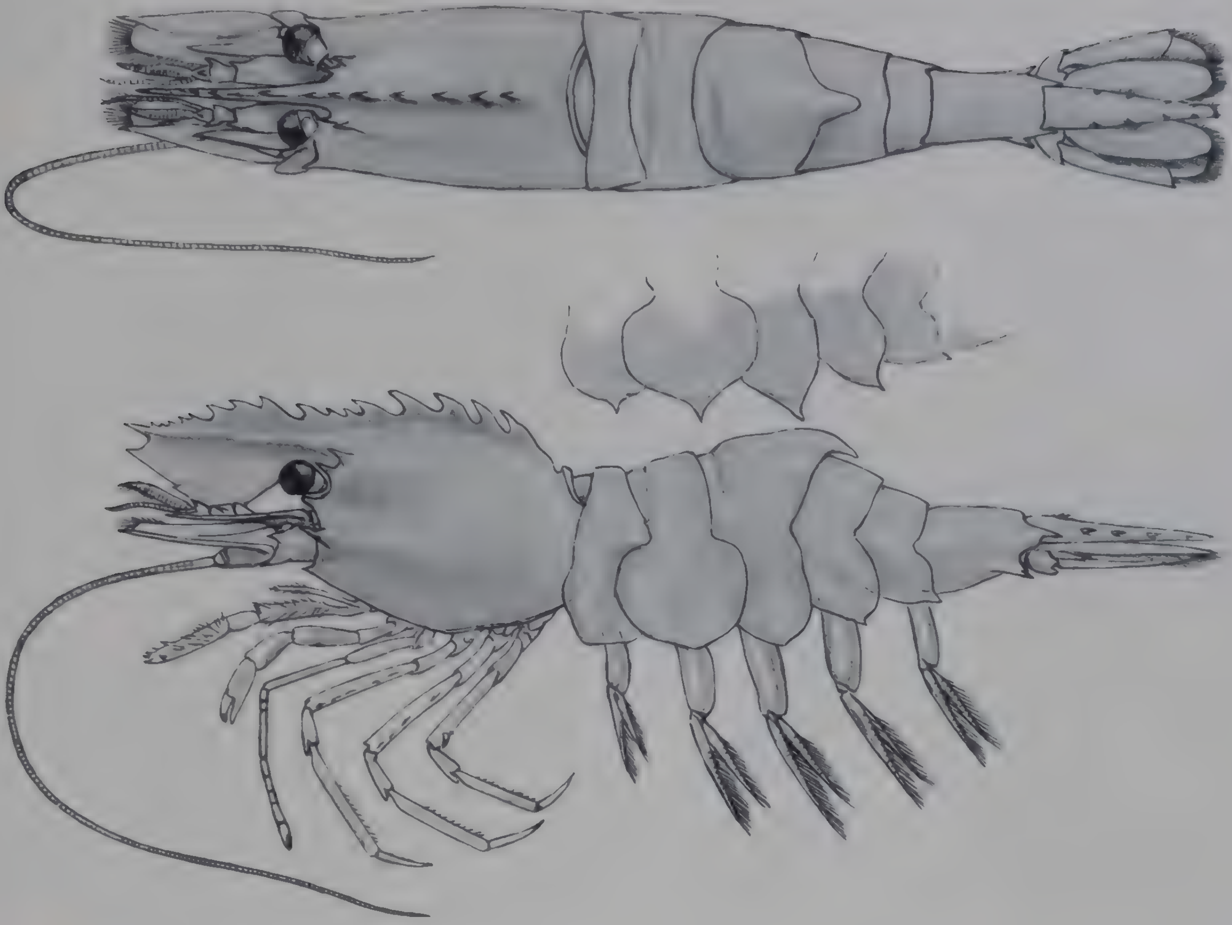
Range Restoration Bay, Burke Channel to San Diego, CA (219); 88–849 m.

The species was first recorded from the British Columbia coast in 1964 (55), on the basis of specimens in Trevor Channel at 110–135 m, June 5, 1954. Subsequent examination of specimens at the Pacific Biological Station revealed that *S. sica* had been collected by Alfreda Berkeley in Howe Sound at 220 m, Aug. 29, 1928.

Biology and economics On the west coast of Canada there are 35 recorded occurrences of some 3960 specimens of *S. sica*. In only 1 case, the capture of 2 specimens off Estevan Point at 110 m, was this shrimp found outside coastal inlets and the Strait of Georgia. There is some evidence from Saanich Inlet (55) that *S. sica*, as an adult, has a pelagic rather than a demersal life. Ovigerous females, 8.6–11.4 mm carapace length, were found in January, March, June, and July. In British Columbia waters and around the San Juan Islands (100), *S sica* is infested by the branchial isopod *Bopyroides hippolytes*.

DANA'S BLADED SHRIMP

Spirontocaris lamellicornis (Dana, 1852)



Description Body stout, little compressed. Shell thick, surface smooth. Rostrum moderately long, 0.7–0.85 carapace length, arising from broad base, outer part as broad blade, upper limb narrower than the deeply convex lower limb, midrib extended as strong spine to extremity, normally no spine on concave margin between midrib and distal ventral spine, $\frac{9\text{-}23}{1\text{-}3}$, including 4 or 5 large dorsal spines on carapace arising from prominent median carina. Carapace spines: 2 supraorbitals fairly closely spaced, about equal in size; suborbital strong, pointed; antennal strong, with supporting carina; pterygostomian moderate. Eye moderate, cornea well developed, process on inner margin of stalk. Antennule: peduncle moderately long, second segment about twice length of third, dorsal distal spine on each of 3 segments; stylocerite long, exceeding peduncle; inner flagellum slightly longer than outer, both barely overreach lamella of antennal scale. Antenna: scale slightly shorter than telson, spine arises from wide outer thickened portion, and exceeds lamella; basicerite, upper pointed lobe, and lower strong spine; peduncle short; flagellum shorter than body. Third maxilliped; moderately long, stout; setiferous exopod; epipod. Pereiopods: I slightly shorter than third maxilliped, stouter, merus with distal spine or lobe; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, stouter; merus, 5–7 spines; propodus, 14–20 spinules, 1 or 2 rows; dactylus slender, about 0.46 propodus length, 7 or 8 minute spines; epipod; IV about as long as III, as stout; merus, 4 spines; propodus, 14–18 spinules, 1 or 2 rows; dactylus slender, about 0.53 propodus length, 7–9 minute spines; V shorter than IV, as stout; merus, 1 or 2 spines; propodus, 12–17 spinules, single row; dactylus slender, about 0.5 propodus length, 7–9 minute spines. Abdomen: pleura of first to third somites each with strong spine on ventral margin (insert above); on specimens having carapaces about 10 mm and longer, spines become obsolescent, enough remaining so that ventral margins not broadly rounded (main drawing above); dorsal posterior margin of third with pronounced pointed lobe; small lobelike projection on dorsal posterior margin of fourth; same somite with strong posterolateral spine; posterolateral margin of fifth with slight lateral spread below articular knob, and with strong spine; sixth shorter than telson, deep at anterior end tapering sharply, strong posteroventral spine with a supporting carina giving a flared margin; telson moderately wide, tapering sharply to acute tip, 4 pairs dorsolateral spines; uropods about equal length, reaching tip of telson.

Remarks J. D. Dana was a naturalist with the U.S. Exploring Expedition, 1838–42, and described 4 shrimps listed in this Bulletin, all based on specimens collected in Puget Sound and Juan de Fuca Strait.

Color Color pattern apparently varying more than on other species of genus. Example of most common type (Plate 6D), is light to dark brown over most of body, pereiopods dark red or almost colorless, banded over tail fan. Another pattern (Plate 2B) has a milkish background more or less uniformly over body, overlaid with fine red mottling interspersed with yellow and brown to black spots on lower surface of carapace, lower limb of rostrum, and most of lower lateral surfaces of first to fifth abdominal somites, and pleopods; sixth somite almost entirely covered with red mottling, tail fan banded; third maxilliped and pereiopods pinkish to red. Striking pattern (not illustrated) has first to fifth abdominal somites milkish with few small patches of yellow; sixth somite, light red to purplish; carapace and rostrum as sixth somite.

Distinctions Rathbun (219) separated *S. lamellicornis* from other bladed shrimps by the acute ventral margins of the first to third pleura. As acuteness of the 3 pleura tends to become obscured in specimens with carapaces about 10 mm and longer, it may be necessary to examine other distinctive characters. These are the rostrum, horizontal with respect to the carapace, and normally with no spine on concave margin from pointed midrib to distal ventral spine; moderate median lobe on dorsal posterior margin of fourth abdominal somite; long, slender dactyli of pereiopods III–V that, to the unaided eye, appear devoid of spines.

Maximum lengths Males: carapace 7.7 mm, total 42 mm; females: carapace 14.6 mm, total 63 mm.

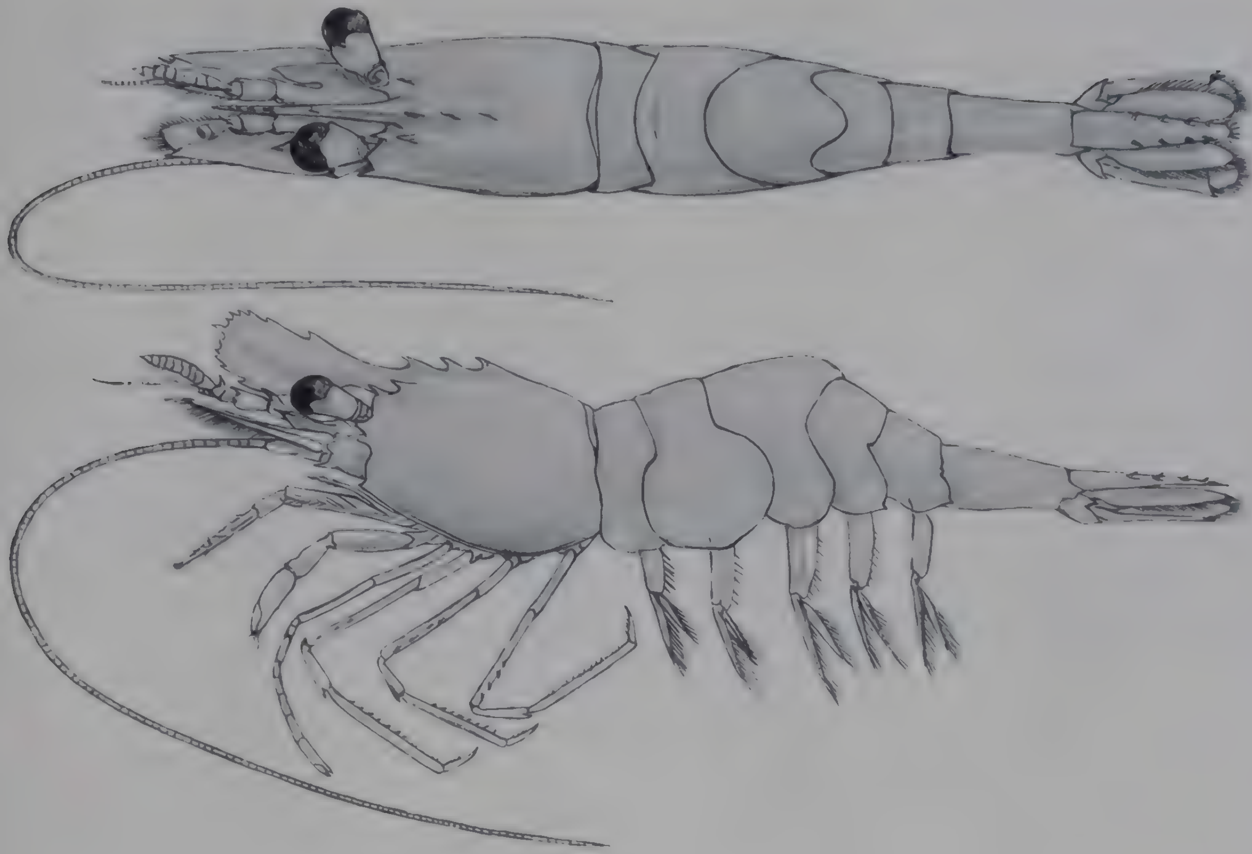
Range Commander Islands, Bering Sea (219); Dutch Harbour, Unalaska to Point Arena, CA (219); 3–192 m (290).

First collected in Canadian waters by the *Albatross* west of Jordan River at 97 m, Sept. 2, 1891 (station 3460) (219).

Biology and economics *S. lamellicornis* appears less common than *S. holmesi* and probably *S. sica,* but occurs more frequently along the entire British Columbia coast than other members of the genus. *S. lamellicornis* has been caught by trawling on a sand to mud bottom at 3–130 m. Earlier (219), the depth range was given as 16–141 m. Ovigerous females, carapace length 9.6–14.6 mm, have been observed in November, February, and March. On the British Columbia coast, and near the San Juan Islands (100), the species is infested by the branchial isopod *Bopyroides hippolytes.*

SNYDER'S BLADED SHRIMP

Spirontocaris snyderi Rathbun, 1902



Description Body slender, little compressed. Shell thin, surface smooth. Rostrum moderately long, 0.7–0.9 carapace length, constricted at base, median to distal section as broad blade, distal end truncated, midrib extended as short spine forming extremity of blade, upper limb narrow than lower, $\frac{8\text{-}10}{3\text{-}5}$, 3 or 4 dorsal spines on carapace widely separated from spines on rostrum. Carapace spines: 2 supraorbitals fairly closely spaced, lower spine stronger; suborbital strong, rounded; antennal moderate; pterygostomian moderate. Eye large, cornea well developed, process on inner margin of stalk. Antennule: peduncle long, third segment about a third length of second, dorsal distal spine on each of 3 segments; stylocerite short, lamellar; inner flagellum longer than outer, both exceed antennal scale, outer setiferous. Antenna: scale about as long as telson, lamella barely exceeds spine; basicerite, upper lateral lobe, lower strong spine; peduncle short; flagellum shorter than body. Third maxilliped: moderately long, moderately stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I; carpus, 7 segments; chelate; epipod; III longer than II, a little stouter; merus, 3 spines; propodus, about 16 spinules, 1 or 2 rows; dactylus slender, about 0.33 propodus length, 4 spines; IV shorter than III, as slender; merus, 3 or 4 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus slender, about 0.33 propodus length, 5 spines; V longer than IV, as slender; merus, 3 or 4 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus slender, about 0.3 propodus length, 6 spines. Abdomen: ventral margin of pleuron of first somite straight or slightly concave; dorsal posterior margin of third produced moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; weak ventral spine on pleuron of fourth; fifth with weak posterolateral spine; sixth shorter than telson, slender, with weak posteroventral spine, and lobe above it; telson narrow, tapering to acute tip, 4 pairs dorsolatera spines; uropods about equal, and exceed telson.

Remarks Snyder collected the type specimen in Monterey Bay, CA (217).

Color Unavailable.

Distinctions Separated from *S. holmesi* and *S. sica* by presence of ventral spine on pleuron of fourth somite of abdomen; characteristic rostrum, as if broken off and "splintered," extending just beyond end of antennular peduncle; presence of process on inner margin of eyestalk.

Maximum lengths Males: carapace 3.3 mm, total 18 mm; females: carapace 4.8 mm total 24 mm.

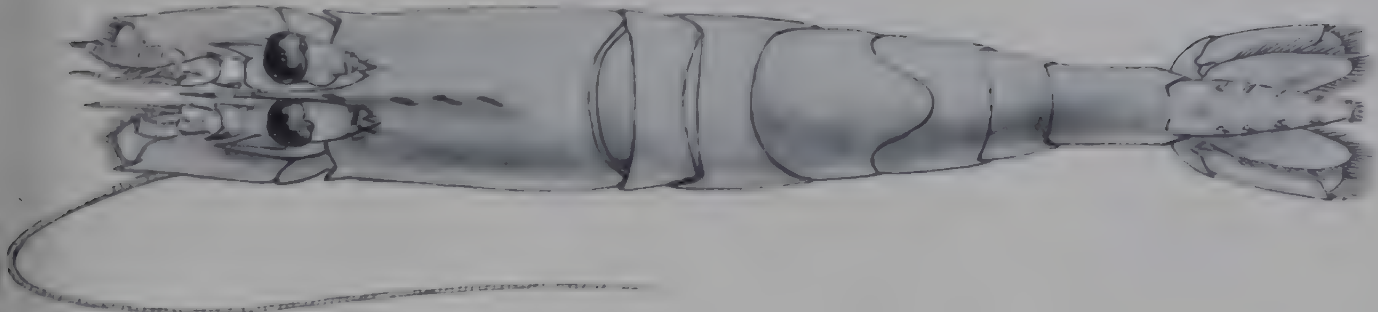
Range Tasu Sound, Queen Charlotte Islands, to Cedros Island, Baja California (219) 4-141 m (258).

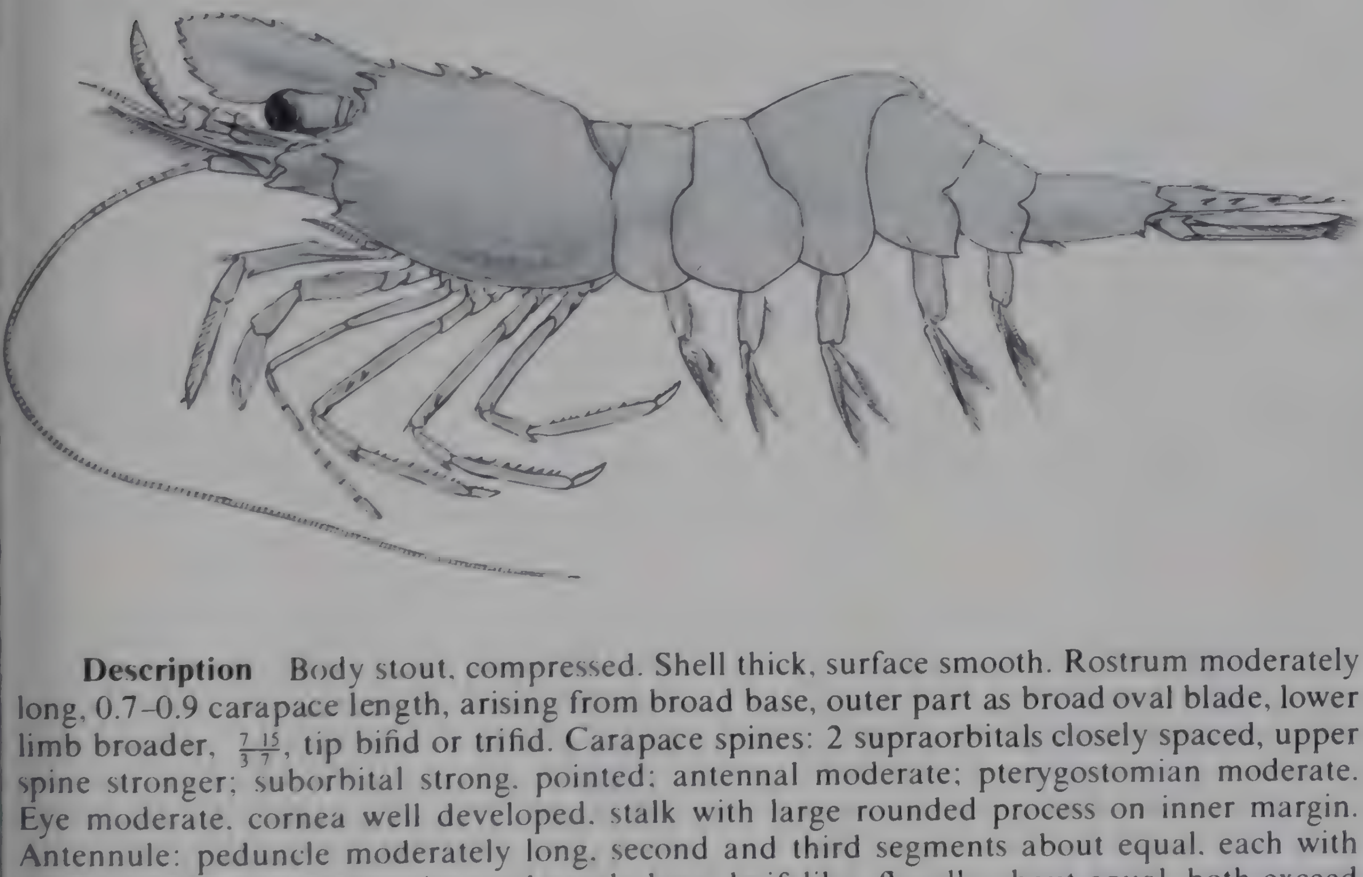
The first reference to the species on the British Columbia coast is in the list prepared by Taylor (258), who also noted, "one specimen from Departure Bay seems to belong here."

Biology and economics *S. snyderi* apparently is fairly rare in local waters. There have been 4 occurrences (7 specimens) at depths shallower than 37 m, the upper limit of the range, as recorded previously (253). Ovigerous females, 4.3-4.8 mm carapace length, were collected in Departure Bay and Cypress Bay during April, and in Tasu Sound in June The branchial isopod, *Bopyroides hippolytes*, is a parasite.

OVAL BLADED SHRIMP

Spirontocaris ochotensis (Brandt, 1851)





Description Body stout, compressed. Shell thick, surface smooth. Rostrum moderately long, 0.7–0.9 carapace length, arising from broad base, outer part as broad oval blade, lower limb broader, $\frac{7\ 15}{3\ 7}$, tip bifid or trifid. Carapace spines: 2 supraorbitals closely spaced, upper spine stronger; suborbital strong, pointed; antennal moderate; pterygostomian moderate. Eye moderate, cornea well developed, stalk with large rounded process on inner margin. Antennule: peduncle moderately long, second and third segments about equal, each with dorsal distal spine; stylocerite moderately long, knifelike; flagella about equal, both exceed antennal scale. Antenna: scale shorter than telson, spine arising from wide outer thickened portion, as long as lamella; basicerite with upper lateral lobe and lower strong spine; peduncle short, flagellum as long as body. Third maxilliped: moderately long, stout; antepenultimate segment, moderate distal spine; epipod; exopod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, somewhat stouter; merus, 2 or 3 spines; propodus, 20–30 spinules, in 1–3 rows; dactylus stout, about 0.25 propodus length, 5 spines; epipod; IV shorter than III, as stout; merus, 1 or 2 spines; propodus, 20–29 spinules, in 1–3 rows; dactylus stout, about 0.26 propodus length, 5 spines; V shorter than IV, as stout; merus, 0 or 1 spine; propodus, 17–35 spinules, in 1–3 rows; dactylus stout, about 0.26 propodus length, 5 spines. Abdomen: dorsal posterior margin of third somite with pronounced projection; strong ventral spine on pleuron of fourth; fifth with moderate posterolateral spine; sixth shorter than telson, with moderate posteroventral spine; telson moderately wide, tapering to acute tip; 4 or 5 pairs lateral spines; inner uropod longer than outer, and reaches, or exceeds, tip of telson.

Remarks British Columbia specimens have shorter dactyli of pereiopods III–V, with respect to their propodi, and fewer spines on each merus of these pereiopods, than specimens described from the western Pacific by Hayashi (115), otherwise, his description fits well. Moreover, because he kindly provided Japanese specimens, it has been possible to confirm identifications of local specimens.

Color Unavailable.

Distinctions Separated from other bladed shrimps by ovoid rostrum barely reaching end of antennular peduncle; 2 supraorbital spines close to each other, and upper stronger; spine of antennal scale reaching end of lamella; and stout bifid dactyli of pereiopods III–V, about 0.25 of their propodi.

Maximum lengths Males: carapace 4.4 mm, total about 22 mm; females: carapace 6.1 mm, total about 31 mm.

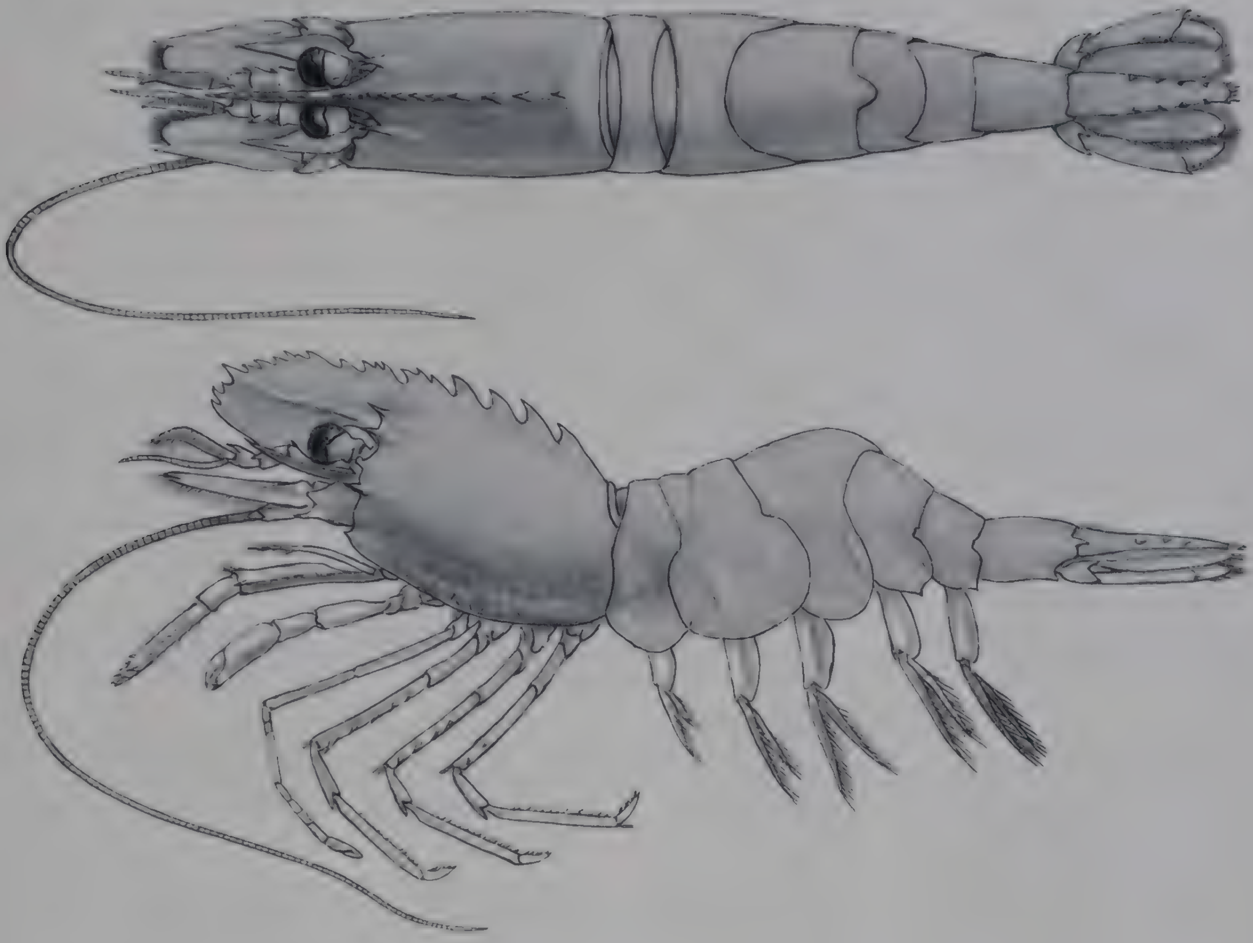
Range Bering Sea (219) to Kyuquot Sound, west coast of Vancouver Island; Okhotsk Sea (266); Sea of Japan, Hokkaido, northeastern Honshu to Onagawa Bay, to Peter the Great Bay; intertidal to 247 m (115).

The first confirmed record of *S. ochotensis* on the British Columbia coast was the collection of 4 specimens in Naden Harbour, Sept. 17, 1955. The species was recorded by Whiteaves (279), but later Smith (242) doubted the identification, considering it to be *S. phippsi.* Capture of *S. murdochi* near Shoal Harbour was reported in 1928 (238), but the specimens perhaps should have been identified as *S. ochotensis.* Neither *S. phippsi,* nor *S. murdochi* has been collected in recent years.

Biology and economics *S. ochotensis* has been collected in the Queen Charlotte Islands, along the northern and central mainland coast, and in Kyuquot Sound, intertidally and in the sublittoral to 9 m. An ovigerous female, 4.0 mm carapace length, was caught in Prescott Passage May 13, 1972. The species occurred intertidally in southeastern Alaska and Prince William Sound at temperatures 13.4–14.3°C and salinities 17.0–28.3‰ (250,43).

RATHBUN'S BLADED SHRIMP

Spirontocaris arcuata Rathbun, 1902



Description *Female* Body stout, little compressed. Shell thick, surface smooth. Rostrum moderately long, 0.6–0.85 carapace length, arising from broad base, outer part as broad blade, upper limb narrower than convex lower limb, midrib extended upward as strong spine to extremity, $\frac{10\text{-}20}{3\text{-}6}$, including 4 or 5 large dorsal spines arising from prominent median carina. Carapace spines: 2 supraorbitals widely spaced, upper larger; suborbital moderate, lobed; antennal strong with supporting carina; pterygostomian moderate. Eye moderate, cornea well developed, process on inner margin of stalk. Antennule: peduncle moderately long, third segment subequal to second, dorsal distal spine on each of 3 segments; stylocerite long, at least exceeding second segment; inner flagellum longer than outer, both overreach lamella of antennal scale, outer setiferous. Antenna: scale shorter than telson, spine arising from outer thickened portion, and exceeds lamella; basicerite, upper lateral pointed lobe, lower strong spine; peduncle short; flagellum about as long as body. Third maxilliped: moderately long, stout; proximal segment with strong distal spine, distal setiferous; exopod; epipod. Pereiopods: I shorter than third maxilliped, stouter; chelate; epipod; II longer than I, slender; carpus, 7 segments; epipod; III about as long as II, a little stouter; merus, 3–5 spines; propodus, about 26 spinules, 1–3 rows; dactylus stout, about 0.32 propodus length, 5 or 6 spines, bifid; epipod; IV shorter than III, as slender; merus, 2–4 spines; propodus, about 28 spinules, 1 or 2 rows; dactylus stout, about 0.3 propodus length, 5–7 spines, bifid; V slightly longer than IV, as stout; merus, 1 or 2 spines; propodus about 25 spinules, 1 or 2 rows; dactylus stout, about 0.3 propodus length, 6 or 7 spines, bifid. Abdomen: pleura of first to third somites with ventral margins rounded; dorsal posterior margin of third with pronounced rounded lobe; fourth and fifth each with posterolateral margin widely recessed at articular knob; ventral margin of fourth pleuron with moderate spine; fifth with moderate posterolateral spine; sixth shorter than telson, stout, with moderate posteroventral spine; telson moderately wide, tapering to blunt tip. 4 or 5 pairs dorsolateral spines; uropods about equal, and as long or longer than telson. *Male* Midrib of rostrum more steeply ascending, upper limb broader (219), also body more slender.

Remarks The present description agrees quite well with Hayashi (115). The main difference is that he describes a longer stylocerite, extending well beyond the antennular peduncle. The common name was chosen as a small tribute to the work by M. J. Rathbun on this genus, and on other taxa of shrimps as well.

Color Mixture of red with chalk white and translucent white, also entire carapace chalk white and abdomen and appendages entirely white (174).

Distinctions Separated from other bladed shrimps with stout bodies and epipods on pereiopods I–III by the following combination of characters: broadly rounded ventral margins of pleura of first to third abdominal somites; dorsal margin of rostrum and carapace forming in profile a generally even convex line; deep bladed ascending rostrum, with lower limb generally projected anteriorly, and 3 or 4 spines on anterolateral (ventral) margin, below extremity of midrib; and relatively short (about one third length of propodus), stout, bifid dactyli of pereiopods III–V.

Maximum lengths Males: carapace 4.2 mm, total 22 mm; females: carapace 10.4 mm, total 46 mm.

Range Canadian Arctic (221); Chukchi Sea (174); Gulf of Anadyr (178), to Juan de Fuca Strait; Okhotsk Sea; Sea of Japan, Maritime Territory (265); 5–641 m (219).

First collected in British Columbia waters by the *Albatross* off Race Rocks at 146 m, Aug. 27, 1891 (station 3444) (219).

Biology and economics It is the author's experience that *S. arcuata* is not common in local waters. The species, however, was collected by the *Albatross* at 6 stations (including 3444 listed above) (219) around the south coast of Vancouver Island, at 88–225 m, Aug. 27–Sept. 4, 1891, suggesting the possibility that it was more abundant in the past. *S. arcuata* is a host of the branchial isopod, *Bopyroides hippolytes* (225), and the abdominal parasite, *Hemiarthrus abdominalis* (225).

Genus *Lebbeus* White, 1847

Rostrum armed, conspicuous or inconspicuous. One supraorbital spine present. Mandible with incisor process and palp of two segments. Eyes well developed. One or more spines on dorsal distal margin of basal segment of antennular peduncle. Third maxilliped without exopod but with epipod. Epipods present on one to three pereiopods. Carpus of second pereiopod with seven segments. Four or more ciliated spines on distal margin of telson.

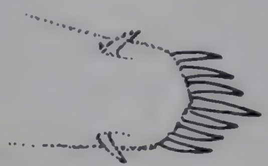
The shrimps of this genus are small to medium in size. Of the some 18 known species, all but four inhabit either the North Pacific or North Atlantic oceans (129, 299). At least two species occur in both oceans.

Four species, called lebbeids here, are known to live along the coast of British Columbia. Based on the number of available specimens, only one species, *L. groenlandicus*, is common. The status of the specimen, tentatively identified in 1964 (55) as *L. zebra* (Leim, 1921), remains in doubt. It closely resembles *L. schrencki* occurring locally, but lacks a conspicuous feature on the second abdominal somite (p. 185). As there is a possibility that *L. polaris,* now known in Alaskan waters, will be found locally, it is included in the following key.

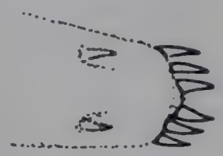
Key to species of genus *Lebbeus*

1 Epipods on first and second pereiopods 2

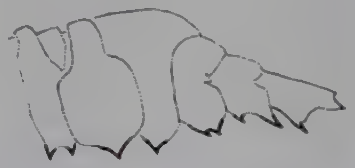
Epipods on first to third pereiopods 3



2 Seven or 9 distal spines inside pair of distolateral spines on each side of telson .... Candy stripe shrimp, *L. grandimanus* (p. 178)

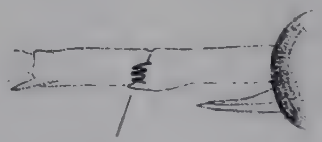


Four or 6 distal spines inside pair of distolateral spines on each side of telson .... [*L. polaris* (Sabine, 1821)]

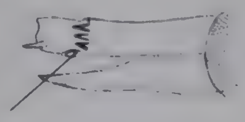


3 Pleura of first to fifth abdominal somites each armed ventrally with 1–3 spines .... Spiny lebbeid, *L. groenlandicus* (p. 181)

Pleura of first to fifth somites without 1–3 ventral spines 4



4 Antennular peduncle extends to near end of antennal scale; 2 or 3 spines (bifid or trifid) on dorsal, distal margin of basal segment of antennular peduncle .... Slope lebbeid, *L. washingtonianus* (p. 183)



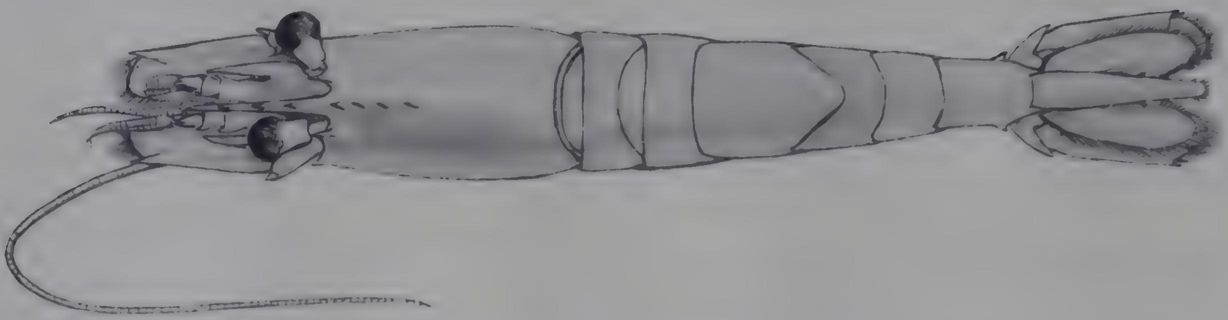
Antennular peduncle extends to near middle of antennal scale; 3 or 4 spines (widely separated) on dorsal, distal margin of basal segment of antennular peduncle 5

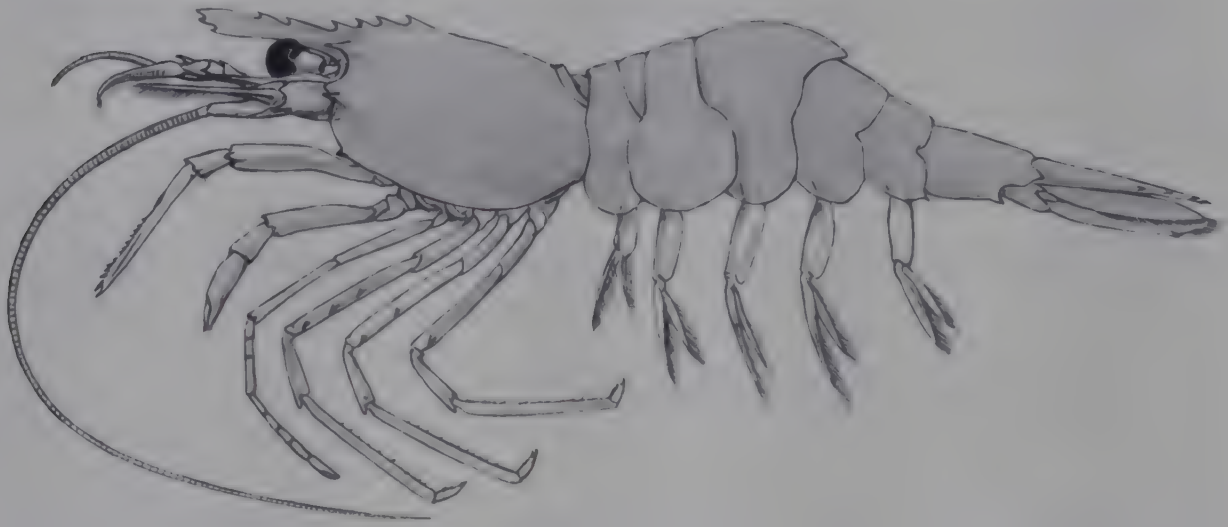
5 Dorsal surface of second abdominal somite with transverse furrow and fold .... Okhotsk lebbeid, *L. schrencki* (p. 185)

Second somite of abdomen without transverse furrow and fold .... Zebra lebbeid, *L. zebra* (p. 176)

CANDY STRIPE SHRIMP

Lebbeus grandimanus (Brazhnikov, 1907)





Other common name: clown shrimp

Description Moderately stout, little compressed. Shell thin, surface smooth. Rostrum moderately long, 0.6–0.9 carapace length, knifelike, horizontal, $\frac{4-7}{1-4}$, tip acute. Carapace spines: supraorbital strong; suborbital strong, rounded; antennal moderate to strong; pterygostomian weak. Eye large, cornea well developed. Antennule: peduncle long, third segment as long as or longer than second, each of 3 segments with dorsal distal spine; stylocerite moderately long; outer flagellum exceeds antennal scale by about half its length, inner a little longer. Antenna: scale shorter than telson, lamella exceeds spine slightly; basicerite, upper lateral lobe, lower strong spine; peduncle moderately long; flagellum shorter than body. Third maxilliped: long, moderately stout; lateral ridge on proximal segment; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, stouter; merus, 2 or 3 spines; propodus, about 20 spinules, 1 or 2 rows; dactylus moderately stout, about 0.23 propodus length, 4 or 5 spines, bifid; IV shorter than III, as stout; merus, 2 spines; propodus, about 24 spinules, 1 or 2 rows; dactylus, moderately stout, about 0.26 propodus length, 4 or 5 spines, bifid; V slightly shorter than IV, as stout; merus, 1 spine; propodus, about 18 spinules, 1 or 2 rows; dactylus moderately stout, about 0.2 propodus length, 3–5 spines, bifid. Abdomen: dorsal posterior margin of third somite produced moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with strong posterolateral spine; sixth shorter than telson, posteroventral spine strong, visibly flared; telson narrow, tapering to rounded tip, 2–4 dorsolateral spines in distal half, 7 or 9 ciliated distal spines inside pair of distolateral spines on each side; outer uropod attains tip of telson, inner a little shorter.

Remarks A male and female, both immature, each has a shorter rostrum (0.43 and 0.51 of carapace length of 3.0 and 4.2 mm, respectively) than described above; each rostral tip does not extend beyond the first segment of the antennular peduncle. Two other specimens examined by the author were from the collection of the British Columbia Provincial Museum, Victoria (BCPM 974-116-10 and BCPM 974-249-8).

Color Background of body pale milkish. Six main bands of yellow and red extend over dorsal and lateral surfaces as follows: 2 on carapace, 1 just posterior to orbit and across anterior dorsal spine, other at about posterior sixth of carapace; 1 on each of second, third, and fifth abdominal somites; 1 at joint of sixth somite and telson, that extends posteriorly along lateral margin of outer uropod; distal part of telson, distal margins of both uropods, eyestalk, and outer margin of antennal scale also yellow and red. Five or 6 light blue solid or interrupted transverse lines are present: the most anterior, across basal part of antennal scale and antennule, may not always occur; 2 on carapace between bands of yellow and red; 1 on each of first, third, and fifth somites; also 2 short longitudinal blue lines, converging posteriorly on dorsal surface of sixth somite. Third maxilliped, pereiopods, and flagella of antennule and antenna mainly yellow (see Frontispiece).

Distinctions If one examines this species when freshly caught, there is no doubt about its identity, as it is the most colorful shrimp known in local waters (Frontispiece). Distinguishing morphological characters are presence of epipods on third maxillipeds, and first and second pereiopods; 7 or 9 ciliated distal spines inside pair of distolateral spines on each side of telson; antennal scale shorter than telson; rostrum normally extending to third segment of antennular peduncle; ventral spine of fourth abdominal pleuron normally absent, if present, spine weak and may occur on only one side.

Maximum lengths Males: carapace 7.8 mm, total 36 mm; females: carapace 9.1 mm, total 45 mm.

Range Bering Sea, Commander Islands (157), Pribilof Islands to San Juan Islands, WA (159) and Race Rocks; Okhotsk Sea; Sea of Japan, to Peter the Great Bay (157); 6–180 m (266). The record from the Pribilof Islands (57°.17′N, 170°.02′W) was the capture of a male (carapace length, 5.6 mm) by *G. B. Reed,* while trawling at 37 m, Nov. 23, 1965.

The species was first caught on the west coast of Canada by *Investigator No. 1,* trawling off Entry Point, 27 m, July 18, 1961, and recorded as *L. polaris* (55).

Biology and economics Biologists have obtained much of the information on *L. grandimanus* by scuba diving. Without underwater observations it is possible that the association of this shrimp with several species of sea anemones would never have been known. N. McDaniel has generously provided the following observations:

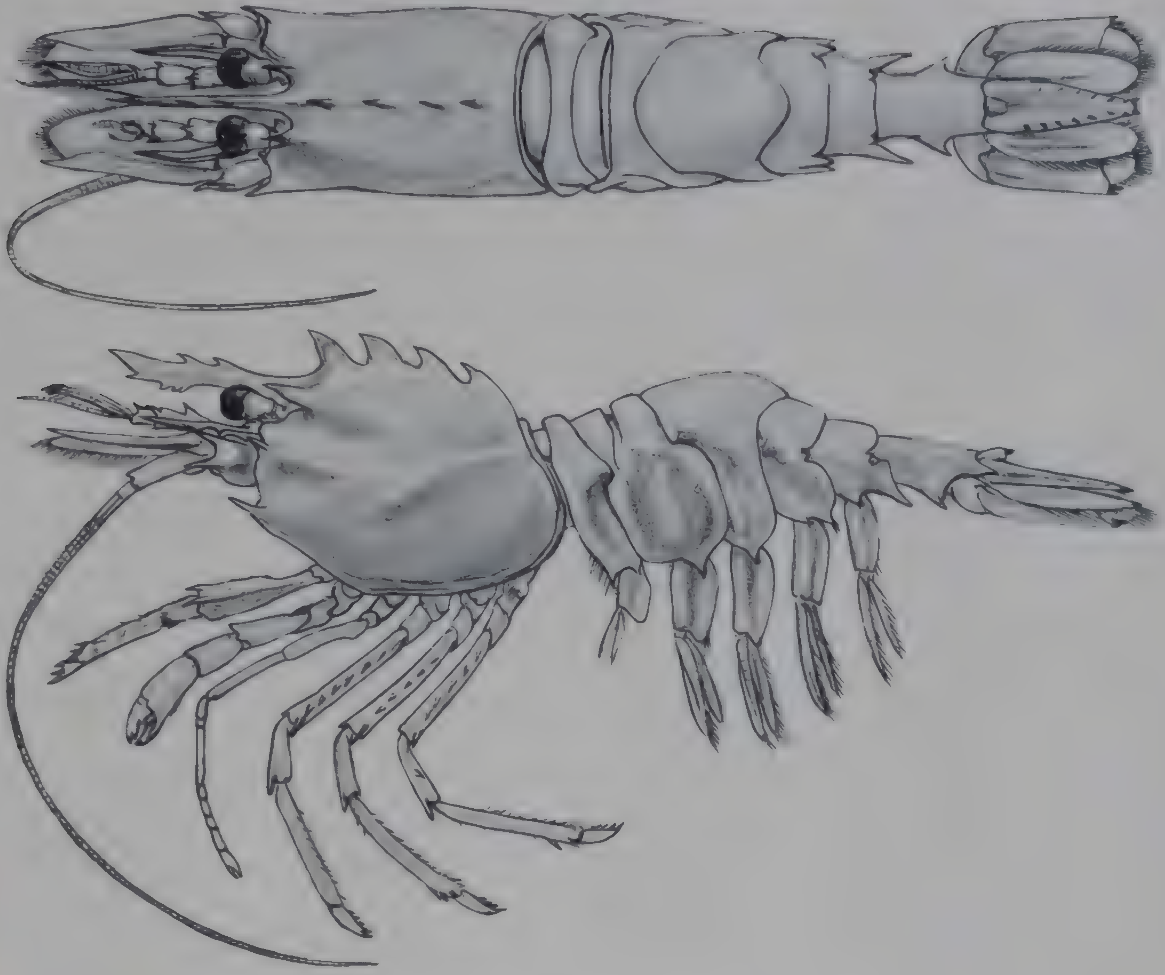
> "This colorful shrimp is usually found associated with the anemone *Cribrinopsis fernaldi,* Sibert and Spaulding, 1976, which is abundant in the inside passages of the coast of B.C., especially in current swept regions. *Lebbeus* may be found in numbers up to 8 per anemone, congregated about the base of the column of the anemone or clinging to the column with tail raised and head down. The shrimps are occasionally found among the tentacles, and are apparently immune to the stinging cells, since they can move about freely without initiating feeding behavior on the part of the anemone. When disturbed the shrimps generally move around the column away from the source of danger. About 50 % of those *Cribrinopsis* examined in the field have associated *Lebbeus;* in northern regions the percentage is higher (ca 80%). Although *Cribrinopsis* is apparently the preferred anemone associate, *Lebbeus* have also been observed associated with *Tealia crassicornis* (Müller, 1776) and *Tealia piscivora* Sebens and Laasko, 1978. Ovigerous females have been observed in February; large specimens are estimated to carry 100–200 eggs."

The association of the shrimp with anemones was reported for the first time, (123), along with aquarium observations of the behavior of associates, and the suggestion that *L. grandimanus* feeds on egested matter and decaying tissue from the surface of the anemone. Five vividly colored shrimps of the genus *Periclimenes* (family Palaemonidae), found in the Indo–Pacific region or the Caribbean area, are known to associate with anemones (134). One, *P. pedersoni* Chace, 1958, occurs frequently in pairs on or around the anemone *Bartholomea annulata* (Lesueur) and has the habit of cleaning reef fishes (300). The shrimp attracts the attention of a fish by whipping its long antennae and, after the fish has approached, the shrimp moves over its surface, removing and eating parasites. The shrimp is also allowed to enter the mouth cavity by way of the gill openings, probably to remove food particles from the gills and teeth. A California shrimp, *Lysmata californica* (Stimpson, 1866) (290), also cleans fishes and the California spiny lobster, *Panulirus interruptus,* but is not associated with an anemone (300).

It is infested by a branchial isopod, identified by the author as *Bopyroides hippolytes.*

SPINY LEBBEID

Lebbeus groenlandicus (Fabricius, 1775)



Description Body stout, little compressed. Shell thick, surface finely pubescent on carapace, parts of abdomen. Rostrum moderately long, 0.6–0.8 carapace length, slender, horizontal, $\frac{5\text{-}7}{2\text{-}6}$, including 4 large dorsal spines on carapace, tip acute. Carapace spines and carinae: supraorbital very strong; suborbital moderate, rounded; antennal very strong, with supporting carina, extending as lateral carina, horizontal or ascending, with some flattening through hepatic region, almost to posterior margin of carapace where it is deflected ventrally; pterygostomian very strong, laterally flared, with slight supporting carina; lateral surface of carapace has depressed regions; between supraorbital and antennal spines; between antennal and pterygostomian spines; ventral to posterior part of branchial carina. Eye moderate, cornea well developed. Antennule: peduncle moderately long, second segment almost twice length of third, 2 dorsal distal spines on basal, single spine on second and third; stylocerite long; inner flagellum longer than outer, former overreaches antennal scale by third or more of its length, outer may or may not exceed scale. Antenna: scale shorter than to longer than telson, wide, spine exceeds lamella; basicerite, 2 very strong lateral spines; peduncle moderately long; flagellum about as long as body, proximal flattening. Third maxilliped: long, moderately stout; proximal segment stouter distally, outer longitudinal ridge ending in strong distal spine, another strong spine more dorsally; epipod. Pereiopods: I shorter than third maxilliped, generally stouter; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III about as long as II, stouter; merus, 7-9 spines; propodus, about 50 spinules, 2 or 3 rows; dactylus stout, about 0.28 propodus length, 4 or 5 spines, bifid; epipod; IV shorter than III, as stout; merus, 6-8 spines; propodus, 46-52 spinules, 2 or 3 rows; dactylus stout, about 0.27 propodus length, 3-6 spines, bifid; V shorter than IV, as stout; merus, 6-8 spines; carpus, 0 or 1 spine; propodus, 40-46 spinules, 2 or 3 rows; dactylus stout; about 0.27 propodus length, 4-6 spines, bifid. Abdomen: second somite with transverse furrow extending from articular knob, adjacent posterior margin with little or no overhang; posterior margin of third somite produced moderately; ventral margins of pleura of first to fourth somites, each with 1 large, and 1 or 2 smaller spines; fifth pleuron, main spine in posteroventral position, smaller one located anteriorly; depressed areas on first to fifth pleura, and anterior lateral surface on sixth somite, generally below articular knobs, finely pubescent; posterolateral margins of fourth and fifth widely recessed at articular knobs, from each of these points a curved carina extends posteriorly; posterolateral margins of fourth and fifth flared laterally, the latter more so; sixth shorter than telson, depressed, posteroventral spine strong, and lobe above, flared laterally; telson wide, tapering to rounded tip; wide median dorsal sulcus; posteriorly directed, fixed tubercle, bearing fine setae, fixed medially on dorsal proximal margin; 5-8 dorsolateral spines on each side; uropods about same length, may or may not exceed telson; fixed spine at posterolateral angle of outer uropod, sometimes reduced.

Remarks Specimens from New Brunswick showed a greater variation in numbers of spines on meri of the posterior pereiopods: III (3-8); IV (2-9); V (1-7) (167). Counts of rostral and telson spines on specimens from the Pacific and Atlantic coasts of Canada were in general agreement. The length of the antennal scale relative to the telson of *L. groenlandicus* varies appreciably, in respect to other Pacific coast shrimps.

Color Not available for Pacific specimens, but on the east coast of Canada the species is brownish red to dull brownish green (167).

Distinctions Distinguished by 4 large dorsal spines on carapace; relatively slender rostrum, armed dorsally and ventrally; large supraorbital spine; 1 or 2 ventral spines (sometimes 3) on each of pleura of first to fifth abdominal somites; long, stout stylocerite, reaching to third segment of antennular peduncle.

Maximum lengths Males: carapace 12.5 mm, total 58 mm; females: carapace 24.6 mm, total 107 mm.

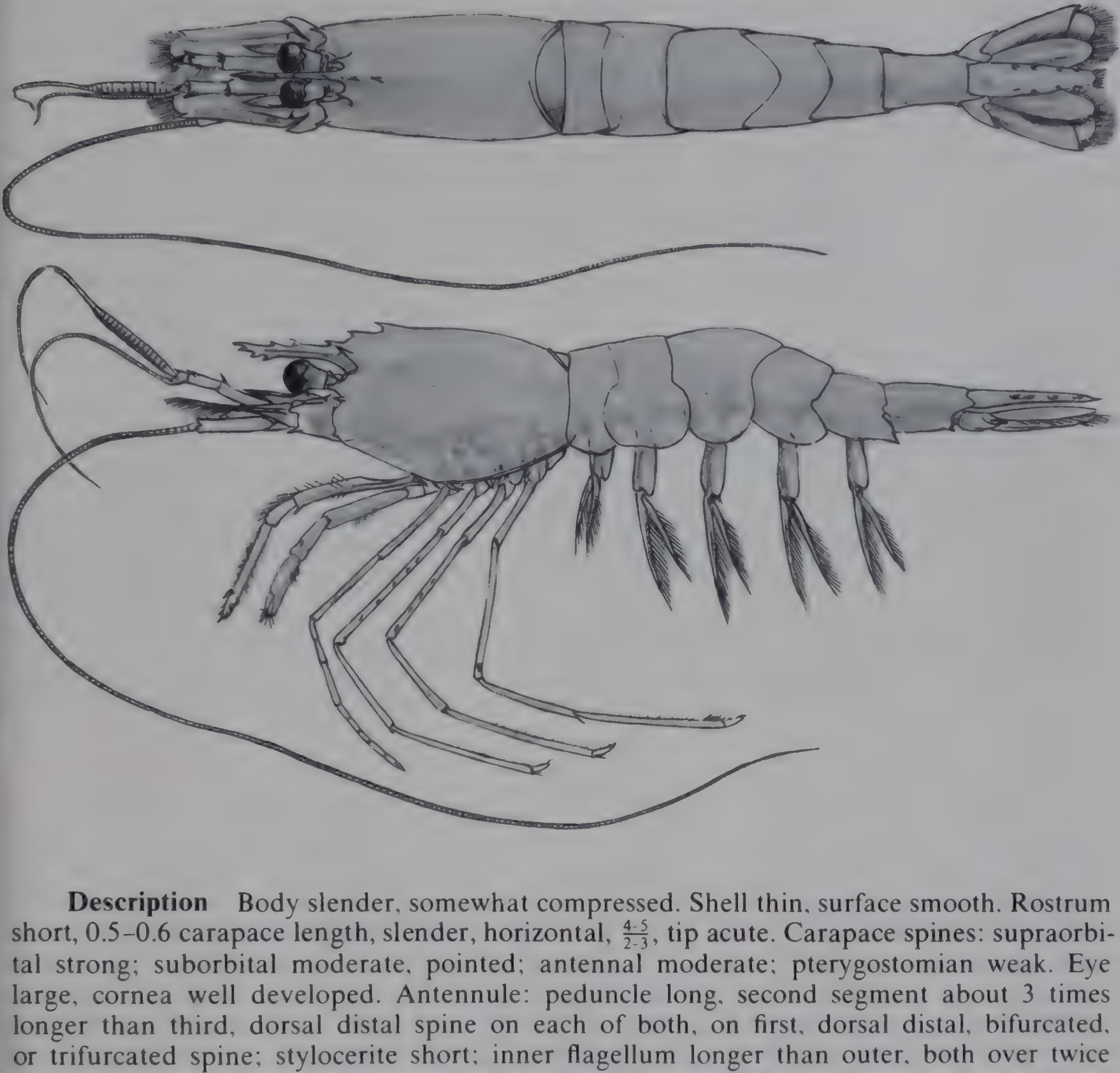
Range Chukchi Sea (265); Bering Sea to Puget Sound (219); Arctic coast of Canada (221, 110); Greenland to Cape Cod (245, 249); Okhotsk Sea (266); Sea of Japan to Peter the Great Bay (266); 11-518 m (219).

The first known record in British Columbia waters was a female dredged from shallow water in the Queen Charlotte Islands by Dawson in 1878 (242).

Biology and economics Specimens captured by trawling in Naden Harbour, Burnaby Narrows, McIntyre Bay, Kitkatla Inlet, Burke Channel, around southeastern Vancouver Island, and elsewhere, 4-248 m, were generally smaller in size (4.0-20.0 mm carapace length). The largest specimens (12.5-24.6 mm carapace length) were trapped in mainland inlets, such as Loughborough, Knight, and Kingcome inlets. Ovigerous females, 11.7-24.6 mm carapace length, have occurred in November, January, and February. Two zoeal stages and the megalopa of *L. groenlandicus* were reared in Kachemak Bay, AK (118). The Atlantic cod is a predator (247), as well as the bearded seal (244). The isopod parasite, *Hemiarthrus abdominalis,* infests this shrimp in Pacific waters but apparently not in the Atlantic Ocean (225).

SLOPE LEBBEID

Lebbeus washingtonianus (Rathbun, 1902)



Description Body slender, somewhat compressed. Shell thin, surface smooth. Rostrum short, 0.5–0.6 carapace length, slender, horizontal, $\frac{4\text{-}5}{2\text{-}3}$, tip acute. Carapace spines: supraorbital strong; suborbital moderate, pointed; antennal moderate; pterygostomian weak. Eye large, cornea well developed. Antennule: peduncle long, second segment about 3 times longer than third, dorsal distal spine on each of both, on first, dorsal distal, bifurcated, or trifurcated spine; stylocerite short; inner flagellum longer than outer, both over twice length of carapace, outer with proximal segments flattened. Antenna: scale about as long as telson, moderately wide, end of lamella skewed toward midline and exceeds spine; basicerite, upper blunt, lower slender lateral spines; peduncle long; flagellum much longer than body. Third maxilliped: long, moderately stout, basal third of proximal segment very slender; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, very slender; carpus, 7 segments; chelate; epipod; III longer than II, a little stouter; merus, 5 spines; propodus, 24–28 spinules, in single row; dactylus slender, about 0.15 propodus length, 6 spines, bifid; epipod; IV about as long as III, as slender; merus, 4 spines; propodus, about 22 spinules, in single row; dactylus slender, about 0.15 propodus length, 7 spines, bifid; V longer than IV, as slender; merus, 1 spine; propodus, about 18 spinules in single row, 6 of these on distal sixth of propodus with 15–20 setae form brush; dactylus slender, about 0.15 propodus length, 7 spines, bifid. Abdomen: dorsal posterior margin of third somite produced moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; weak ventral spine on pleuron of fourth; fifth with strong posterolateral spine; sixth with weak posteroventral spine and small lobe above it; telson moderately wide, tapering to acute tip, 4–6 pairs dorsolateral spines; uropods about equal, and both exceed telson.

Remarks The third maxilliped of the specimen illustrated, when extended forward, overreaches the end of the antennal scale by a third of its distal segment, instead of half, as described (217). Lengths of all pereiopods are in agreement with those statements.

Color Unavailable.

Distinctions *L. washingtonianus* is distinguished by a supraorbital spine; a long antennular peduncle almost overreaching the end of the antennal scale; first segment of antennular peduncle with dorsal distal, bifurcated or trifurcated spine; epipods on pereiopods I–III; pereiopods II–V, when extended forward, overreach end of antennal scale considerably.

Maximum lengths Males: carapace 9.4 mm, total 43 mm; females: carapace 9.0 mm, total 39 mm (219).

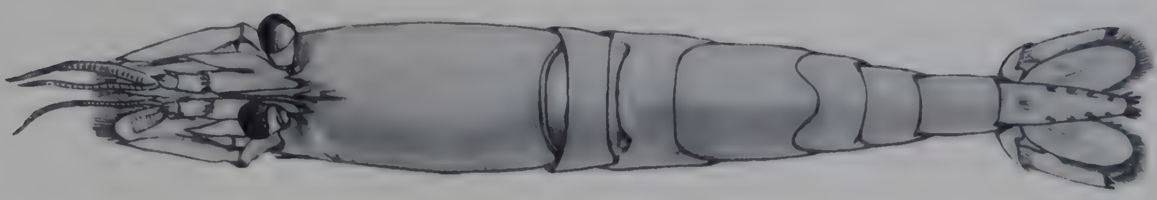
Range Anthony Island, Queen Charlotte Islands, to San Clemente Island, CA (232); 820 (232) to 1808 m (283).

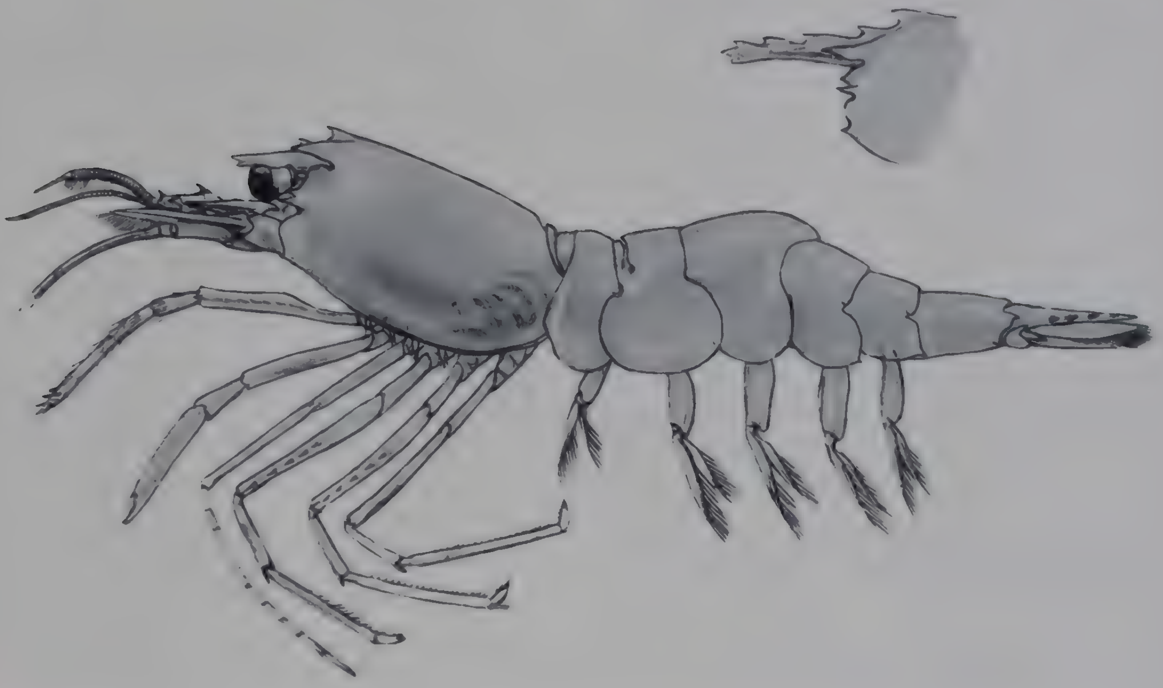
First collected in British Columbia waters by F. R. Bernard, trawling with *G. B. Reed*, off Anthony Island at 1069 m, Sept. 17, 1971.

Biology and economics Only 1 specimen, a male 9.4 mm carapace length off Anthony Island, has been collected in Canadian Pacific waters. There are earlier records off Sealion Rock, WA (219), and from 5 localities off the southern California coast (232, 283). Wicksten (283) states that *L. washingtonianus* is strictly an inhabitant of the continental slope. There is evidence that on the slope it may have an even more restricted habitat. The tow off Anthony Island was set in a submarine trench, and the stations listed by Wicksten were located in deep trenches and basins. Information on the bottom topography at *Albatross* station 3071 off Sealion Rock, where the type specimen was caught (217), is unavailable.

OKHOTSK LEBBEID

Lebbeus schrencki (Brazhnikov, 1907)





Description Body moderately stout, shell thick, surface smooth. Rostrum short, 0.3–0.5 carapace length, slender, slightly descending, $\frac{2-5}{1}$, tip acute. Carapace spines: supraorbital very strong, may obscure part of rostral base; suborbital strong; antennal strong; pterygostomian moderate; lower anterior margin produced as broadly rounded lobe. Eye moderate, cornea well developed. Antennule: peduncle long, third segment subequal to second, each has dorsal distal spine, first segment with 3 or 4 widely separated, dorsal distal spines; stylocerite reaching end of second segment; inner flagellum longer than outer, both extend beyond antennal scale by more than half their lengths, outer setiferous. Antenna: scale about as long as telson, moderately wide, spine exceeds lamella slightly; basicerite, upper lateral lobe, lower strong spine; peduncle moderately long; length of flagellum unavailable. Third maxilliped: long, moderately stout; proximal segment with outer lateral ridge, armed with about 10 spinules and spine at distal end; distal segment setiferous; epipod. Pereiopods: I shorter than third maxilliped, stouter; merus, spinules on inner margin; chela, 0.5–0.7 carapace length; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III shorter than II, stouter; merus, proximal end inflated, 5 or 6 spines; propodus, about 16 spinules, 1 or 2 rows; dactylus stout, about 0.2 propodus length, 4 or 5 spines, bifid; epipod; IV shorter than III, more slender; merus, slightly inflated, 5 spines; propodus, about 22 spinules, 1 or 2 rows; dactylus stout, about 0.2 propodus length, 4 or 5 spines, bifid; V about as long as IV, more slender; merus, 0 spine; propodus, about 20 spinules, 1 or 2 rows; dactylus stout; about 0.18 propodus length, 4 or 5 spines, bifid. Abdomen: anterior lateral margin of pleuron of first somite lobed; second segment with deep dorsal transverse furrow, partly hooded by adjacent fold in shell; posterior margin of third somite produced moderately; posterolateral margins of fourth and fifth deeply recessed at articular knobs; pleuron of fourth with weak ventral spine; fifth with posterolateral spine; sixth shorter than telson, stout, posteroventral spine moderate; telson moderately wide tapering to rounded point, 6 distal spines, 3 or 4 pairs dorsolateral spines; uropods about equal, and extended beyond telson.

Remarks The structure on the dorsal surface of the second abdominal somite, comprised of a transverse furrow and fold, apparently was unreported previously. It is present on 4 specimens, all females, at hand – 1 from Passage Island, 1 from Burke Channel, and 2 caught near Auke Bay, AK (Auke Bay Fisheries Laboratory collection AB75–106). A female specimen caught in Checleset Bay in 1962, and recorded tentatively as *Lebbeus zebra* (Leim 1921) (55), agrees in most respects with specimens above, identified as *L. schrencki*, but lacks transverse furrow and fold. The author has learned through the generosity of K. Hayashi that specimens of *L. possjeticus* Kobjakova, 1967 and an undescribed lebbeid in his collection have the furrow more or less hooded by the fold. He also reports that *L. brandti* (Brazhnikov 1907) and *L. groenlandicus* (p. 181) have a more distinct furrow, not hooded by the fold. It is assumed that the structure is an adaptation to permit the posterior margin of the first somite to slide into the furrow on the second, thus facilitating assumption of the defensive cataleptic position when the dorsal surface is bridged (9), as if the telson were to meet the rostrum.

The main differences between the 4 available specimens and the original description of *L. schrencki*, based on 3 females, are stronger supraorbital spine, lack of slight sculpturing on carapace, fewer rostral spines, and slightly longer chela of pereiopod I. The main drawing (p. 185) is of the female captured off Passage Island (as the actual specimen lacks meral spines on pereiopods III and IV, these were drawn from another specimen); the insert is of the rostrum and anterior margin of the carapace of one of the Auke Bay specimens. The male of *L. schrencki* reportedly had a very large supraorbital spine; the chela of pereiopod I, 0.8 of the carapace length; the dactylus of pereiopod V, 0.13 of the propodus length; and the pleuron of the fourth somite without a ventral spine (46).

Color Unavailable.

Distinctions *L. schrencki* is distinguished from other lebbeids now known in local waters by 3 or 4 separate spines on dorsal distal margin of first segment of antennular peduncle; transverse furrow and fold on dorsal surface of second abdominal somite; and lobe on anterolateral margin of pleuron of first somite.

Maximum lengths Males: carapace 6.9 mm, total 30 mm; females: carapace 11.5 mm, total 43 mm.

Range Auke Bay, southeastern Alaska, to Passage Island, Strait of Georgia; Okhotsk Sea; Sea of Japan, to Peter the Great Bay (266); 12–183 m.

First known capture of *L. schrencki* on the British Columbia coast was off Passage Island at 183 m, Dec. 11, 1963.

Biology and economics This shrimp apparently is comparatively rare along the Canadian and Alaskan coasts, as well as in Asian waters (157). Near Auke Bay it was found on a bottom of sand to muddy silt, and on mud at 2 British Columbia localities.

Genus *Eualus* Thallwitz, 1892

Rostrum conspicuous and armed; in most species, no longer than carapace. Antennal and pterygostomian spines present; supraorbital and branchiostegal spines absent. Eyes usually well developed. Mandible with palp of two segments and incisor process. Third maxilliped with exopod and epipod. Pereiopods lacking exopods; epipods present or lacking; first and second pereiopods chelate; carpus of latter with seven segments. Members of this genus, called eualids here, are small shrimps, occurring from moderate to abyssal depths. Of the 19 known species, 17 are distributed in the northern hemisphere. Although eualids are not utilized commercially, they appear incidentally in pandalid shrimp catches from Northern Pacific and North Atlantic regions. Ten species have been reported from British Columbia waters.

Key to species of genus *Eualus*

1 No epipod on any pereiopod 2

Epipods usually on first, sometimes on second and third pereiopods 4

2 Rostrum shorter than carapace .... Large-eyed eualid, *Eualus macrophthalmus* (p. 189)

Rostrum as long or longer than carapace 3

3 Posterior margin of each of third to sixth abdominal somites armed with median dorsal spine .... Barbed eualid, *Eualus barbatus* (p. 190)

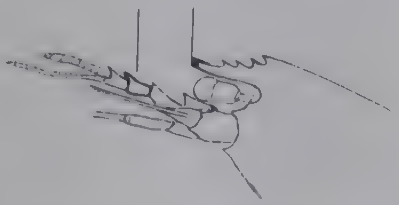
Third to sixth abdominal somites not armed with median dorsal spines .... Deepsea eualid, *Eualus biunguis* (p. 192)

4 Epipods on all 3 pereiopods 5

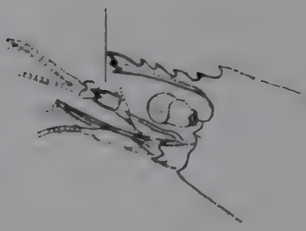
Epipods usually on first, sometimes on second pereiopods 8

5 Rostrum with dorsal margin markedly convex over eye, 7–14 spines .... Beaked eualid, *Eualus avinus* (p. 193)

Rostrom nearly straight over eye, fewer (2–9) spines 6



6 Rostrum not reaching second segment of antennular peduncle .... Doll eualid, *Eualus pusiolus* (p. 195)



Rostrum reaching second segment of antennular peduncle 7

7 Pleuron of fourth abdominal somite with ventral spine .... Striped eualid, *Eualus herdmani* (p. 197)

Pleuron of fourth abdominal somite lacks spine .... Berkeleys' eualid, *Eualus berkeleyorum* (p. 199)

8 Normal size epipods on first and second pereiopods .... Townsend's eualid, *Eualus townsendi* (p. 201)

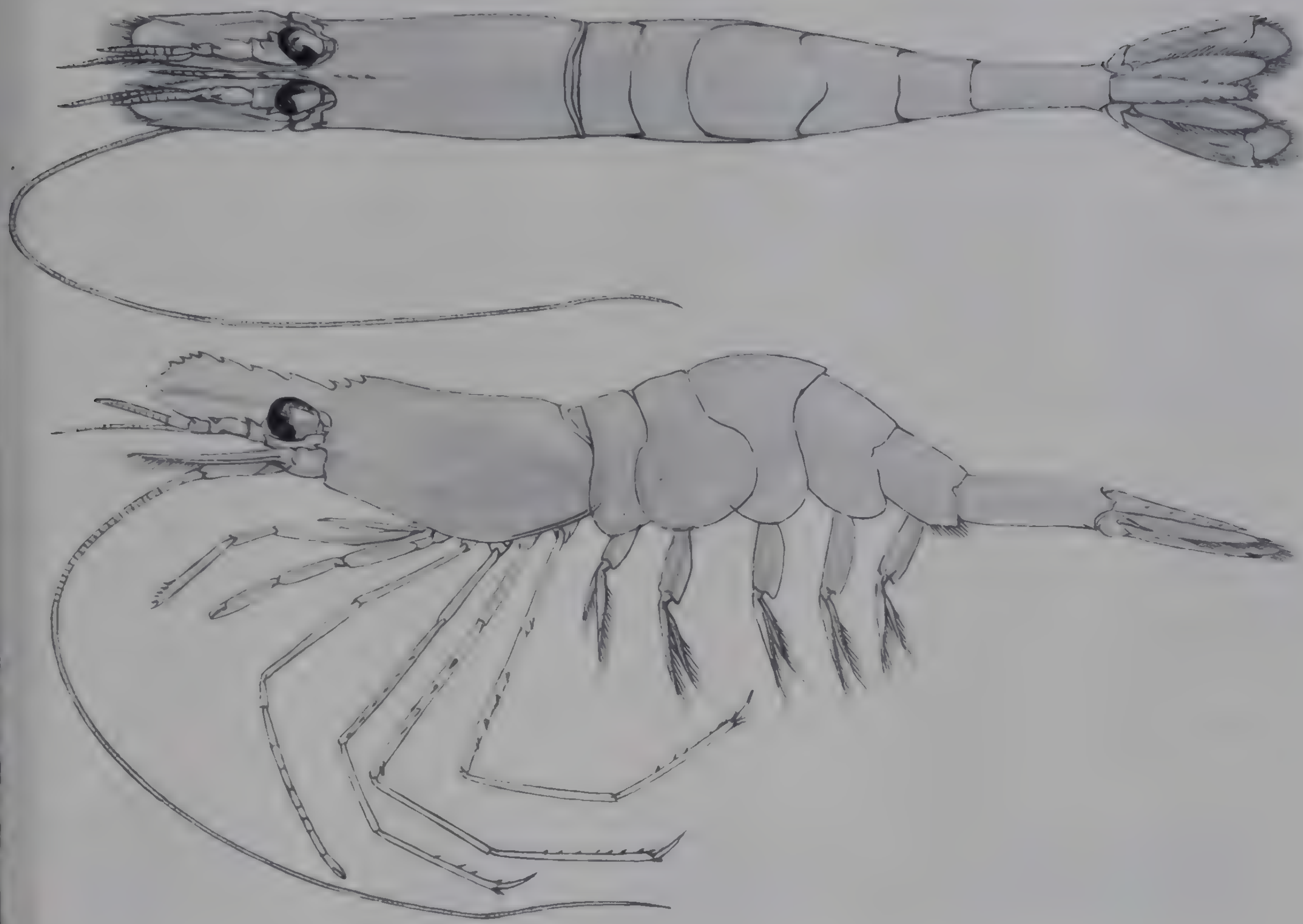
Normal size epipods or reduced normally on first, sometimes on second pereiopods, but reduced in size 9

9 Most of distal part of rostrum lacking spines on dorsal margin .... Arctic eualid, *Eualus fabricii* (p. 203)

Distal half of rostrum with dorsal spines .... Short-scaled eualid, *Eualus suckleyi* (p. 204)

LARGE-EYED EUALID

Eualus macrophthalmus (Rathbun, 1902)



Description Body moderately slender, somewhat compressed. Shell thin, smooth. Rostrum short, about 0.8 carapace length, horizontal, upper and lower limbs wide with convex margins, $\frac{10-14}{1-4}$, tip acute. Carapace spines: suborbital small, rounded; antennal strong; pterygostomian minute or absent. Eye very large, cornea curved inward almost to peduncle base. Antennule: peduncle moderately long, second segment 3 times length of third, terminal spines on each of latter segments, stylocerite short; both flagella exceed antennal scale, inner slightly longer. Antenna: scale tapers distally, lamella considerably exceeding spine; basicerite, 2 lateral spines; peduncle moderately long; flagellum about 1.3 body length. Third maxilliped: long, slender; exopod; epipod. Pereiopods: I shorter than third maxilliped and stouter; chelate; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, slender; merus, 5 or 6 spines; propodus, 4 or 5 spinules; dactylus slender, about 0.33 propodus length, 3 or 4 spines; IV longer than III, slender; merus, 5 or 6 spines; propodus, 3–7 spinules, clump of setae at distal end; dactylus about 0.31 propodus length, 2–4 spines; V shorter than IV, slender; ischium, 0 or 1 spine; merus, 4 spines; propodus, 3 spinules and dense clump of setae at distal end; dactylus, about 0.27 propodus length, 2 or 3 spines; epipods absent. Abdomen: first to fourth somites lack spines; dorsal posterior margin of third moderately lobed; pleuron of fifth with moderate posterolateral spine, sixth elongate, moderate posteroventral spine; telson, 5 or 6 pairs of dorsolateral spines; inner uropod longer than telson, outer exceeds inner considerably.

Color Pale yellow over most of body, overlaid with faint red speckling that become more intense on distal parts of pleopods, pereiopods, antennae, and uropods (Plate 8A).

Distinctions A eualid with very large eyes and lacking epipods on the pereiopods characteristic ovoid rostrum shorter than carapace distinguishes it from deep-sea eualid.

Maximum lengths Males: carapace 8.8 mm, total 43 mm; females: carapace 15.2 mm total 71 mm.

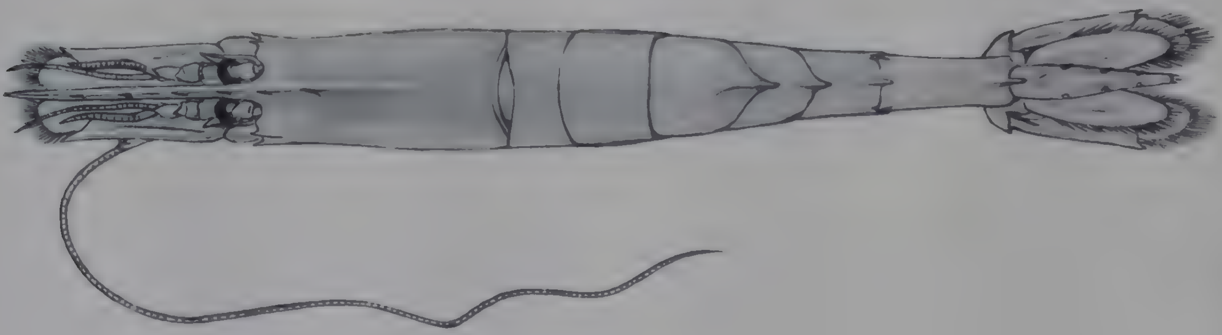
Range Unalaska to Point Sur, CA; 110–1163 m (219).

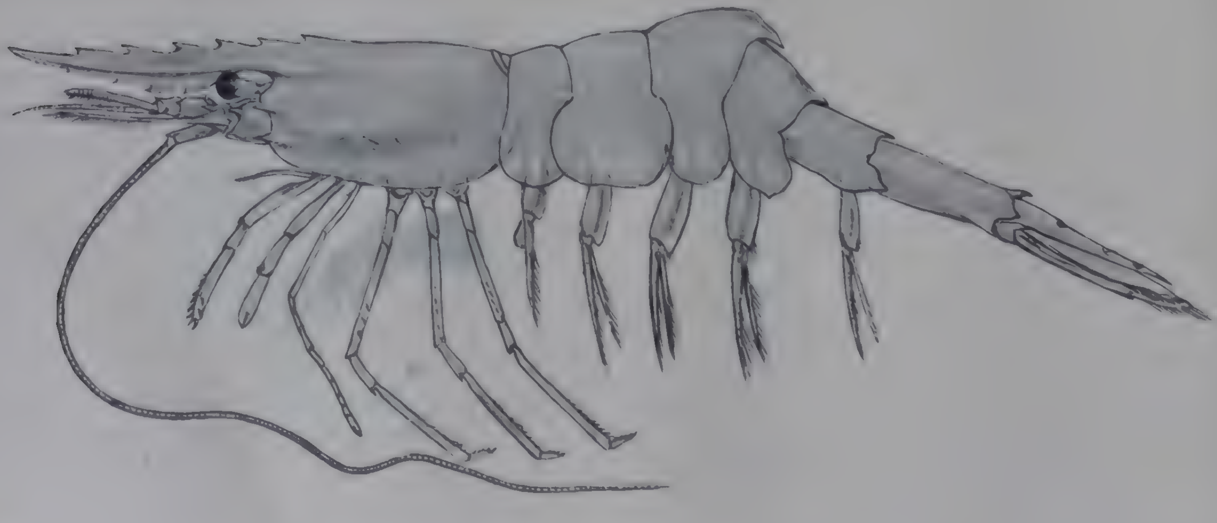
First taken in British Columbia waters by the *Albatross* Aug. 31, 1888, about 97 km northwest of Cape Scott at 373 m (station 2861) (219).

Biology and economics All collections by the *Albatross* were made in outer coastal areas at considerable depths. More recently, it has been trawled shallower than 183 m in inlets (54). It is likely this shrimp is pelagic for most of its life. An ovigerous female carapace length 12.3 mm, was caught in Smith Sound, 165–179 m, Mar. 10, 1963. The large-eyed eualid has 2 abdominal parasites, the isopod *Hemiarthrus abdominalis* (225) and the rhizocephalan *Sylon hippolytes.*

BARBED EUALID

Eualus barbatus (Rathbun, 1899)





Description Body moderately stout, somewhat compressed. Shell thin, smooth. Rostrum moderately long, about 1.3 carapace length, horizontal, upper limb narrower than lower, spines $\frac{5\text{–}8}{10\text{–}20}$, posterior 3 or 4 ventral large, others minute, tip acute. Carapace spines: suborbital weak, rounded; antennal strong with supporting carina: pterygostomian strong and high on frontal margin. Eye moderately large, cornea well developed. Antennule: peduncle short, second segment longer than third, stylocerite short; inner flagellum somewhat longer than antennal scale, outer shorter. Antenna: scale oblong, lamella exceeding spine; basicerite, 2 lateral spines; peduncle short; flagellum almost equalling body length. Third maxilliped: short, stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; II longer than I, very slender; carpus, 7 segments; chelate; III longer than II, moderately stout; merus, 3 or 4 spines; propodus, about 30 spinules, 2 rows; dactylus stout, about 0.25 propodus length, 5 spines; IV slightly shorter than III, as stout; merus, 4 or 5 spines; propodus, about 20 spinules, 2 rows; dactylus stout, about 0.20 propodus length, 5 spines; V slightly shorter than IV, as stout; merus, 4 or 5 spines; propodus, about 25 spinules, 2 rows; dactylus stout, about 0.17 propodus length, 5 spines; exopods absent. Abdomen: third to fifth somites each with distinct median dorsal carina, extended posteriorly in third as conspicuous lobe; third to sixth each armed posteriorly with slender, barblike spine; pleuron of fourth with weak ventral spine; fifth with strong posterolateral spine; sixth elongate; telson, 3 pairs dorsolateral spines; inner uropod reaches tip of telson, outer extends beyond it considerably.

Color Minute light orange spots scattered over whole body and appendages, but form irregular vertical bands on abdomen and carapace. Third maxilliped and pereiopod I light orange (Plate 5C).

Distinctions Distinguished from all other Pacific eualids by the presence of barblike spines on median dorsal surfaces of third to sixth abdominal somites; strong pterygostomian spine, high on frontal margin of carapace.

Maximum lengths Males: carapace 12.4 mm, total 76 mm; females: carapace 15.9 mm, total 95 mm.

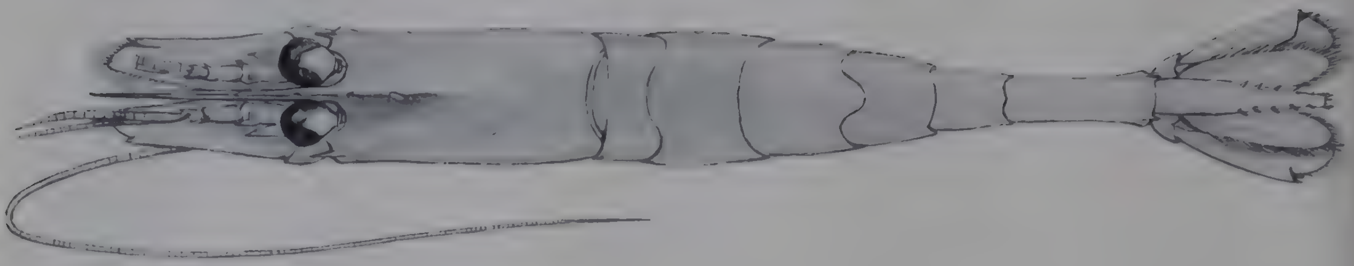
Range Pribilof Islands to Hecata Bank, OR (219, 228); 82–507 m (219).

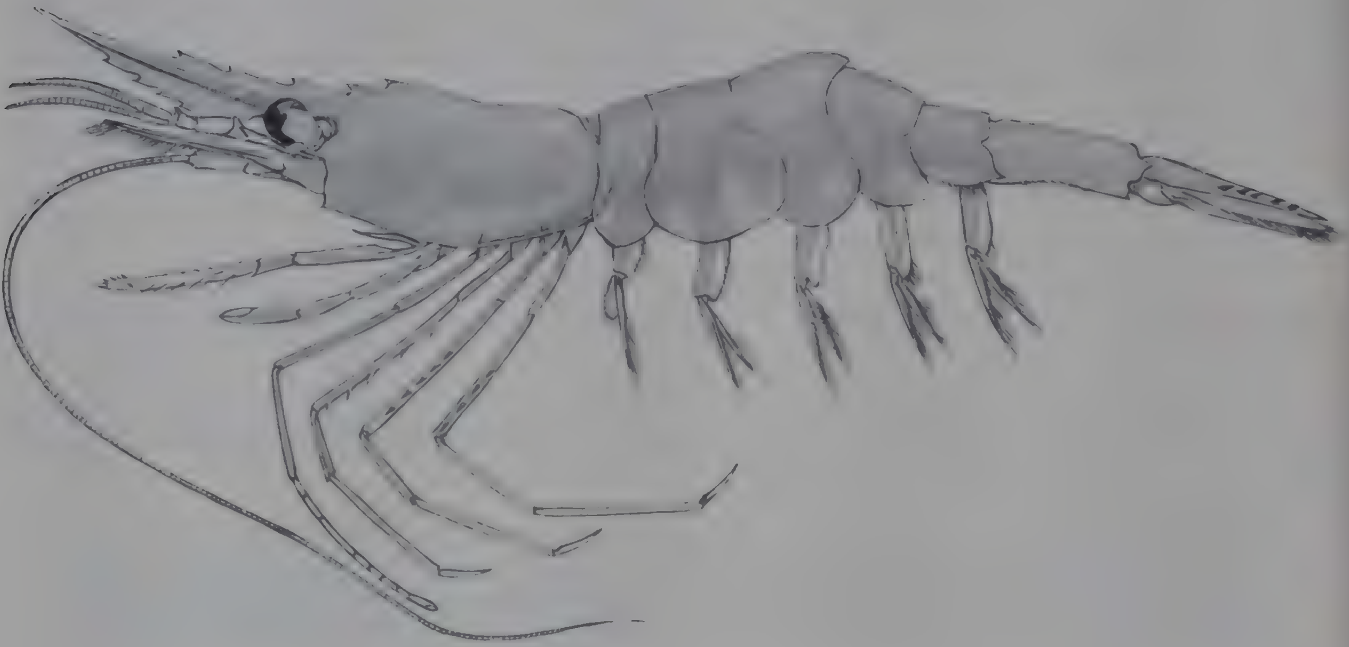
First taken in British Columbia waters by the *Albatross* Sept. 2, 1891, off Port San Juan at 225 m (station 3459) (219).

Biology and economics The barbed eualid occurs sparingly on some local shrimp grounds. It appears to prefer a soft mud bottom. Two ovigerous females, carapace lengths of 13.5 and 14.1 mm, were caught in Smith Sound, 119–128 m, Mar. 16, 1963. The first zoea of the species was described from a laboratory hatching (145). It is parasitized by the isopod, *Hemiarthrus abdominalis.*

DEEPSEA EUALID

Eualus biunguis (Rathbun, 1902)





Description Body slender, slightly compressed. Shell thin, smooth. Rostrum long, 1.2–1.7 carapace length, somewhat ascending; upper limb narrower than lower; $\frac{5-7}{4-7}$, tip acute. Carapace spines: suborbital small; antennal strong; pterygostomian weak. Eye very large, cornea curved inward to base of stalk. Antennule: peduncle moderately long, second segment much longer than third, each with dorsal distal spine; stylocerite moderately long; outer flagellum somewhat longer than antennal scale, inner about twice its length. Antenna: scale tapers distally; lamella exceeds spine considerably; basicerite with 2 lateral lobes; peduncle moderately long; flagellum longer than body. Third maxilliped: long, moderately stout; exopod; epipod. Pereiopods: I very short, stout; chelate; II over twice length of I, very slender; carpus, 7 segments; chelate; III and IV both as long as II, very slender; V slightly longer than IV, very slender; III–V each merus with 4–6 spines; each dactylus slender, long, about 0.22 propodus length, armed with 5 or 6 spines on flexor margin, distal of which, with dactylus, simulates a minute chela; pereiopods lack epipods. Abdomen: all somites lack median dorsal carinae; fifth with moderate posterolateral spine; sixth elongate; telson, 5 or 6 pairs of dorsolateral spines; inner uropod reaches end of telson, shorter than outer.

Color Background yellow; carapace with red patches, whitish patches over branchial region; midrib of rostrum distinctly red, as well as most anterior appendages and pereiopods; dorsal parts of abdominal somites and pleopods red; whitish patches on first 3 pleura of abdomen. Some white patches on pereiopods proximally; sixth somite almost entirely red (Plate 6C).

Distinctions Distinguished by very large eyes, long rostrum with terminal third devoid of spines and sharply pointed, and chelalike appearance of dactyli of last 3 pereiopods.

Maximum lengths Males: carapace 8.7 mm, total 49 mm; females: carapace 17.4 mm, total 99 mm.

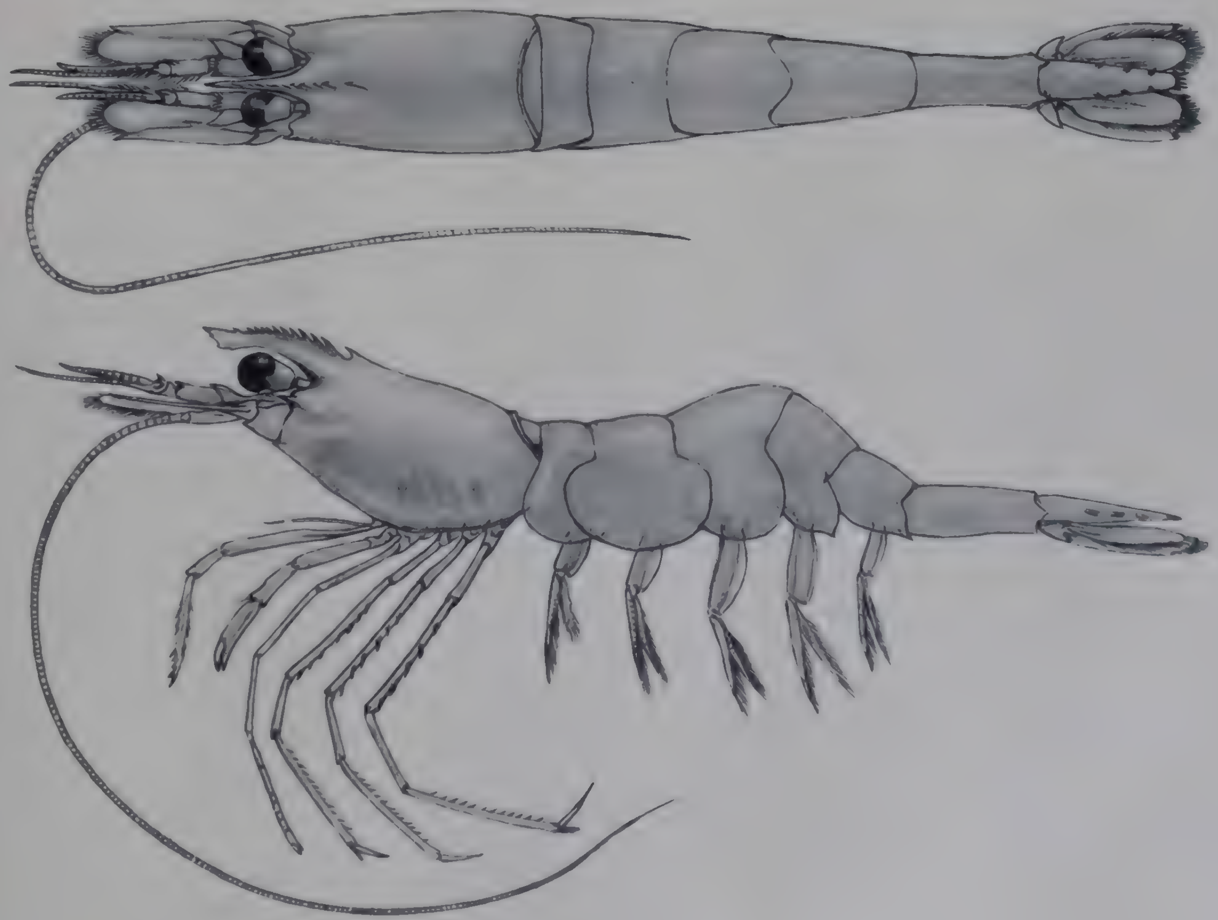
Range Cape Navarin, Bering Sea to Oregon; Okhotsk Sea; Sea of Japan to Sado Island, and Peter the Great Bay (219, 297, 266); 90–2090 m (38).

First taken in British Columbia waters by the *Albatross* Aug. 29, 1888, west of Moresby Island, 1602 m (station 2860 also type locality) (217, 219).

Biology and economics This species has been termed as semibathypelagic (265). It occurs in British Columbia mainly along the lower continental slope. An ovigerous female, carapace length 16.0 mm, was caught off Anthony Island, 1134–1229 m, Feb. 18, 1972. The deepsea eualid is parasitized by *Hemiarthrus abdominalis* (225). There is a detailed description of Japanese specimens (192).

BEAKED EUALID

Eualus avinus (Rathbun, 1899)



Description Body slender, somewhat compressed. Shell thin, smooth. Rostrum short, about 0.5 carapace length, strongly arched and tip slightly descending; $\frac{12-14}{1-2}$. posterior 2 of dorsal, large and separated from others; tip acute. Carapace spines: suborbital small, rounded; antennal strong; pterygostomian weak. Eye fairly large, cornea well developed. Antennule: peduncle long, second segment about twice length of third, each with dorsal distal spine, stylocerite short; inner flagellum longer than outer, both shorter than antennal scale. Antenna: scale oblong, tapering slightly, lamella exceeding spine; basicerite, 2 lateral spines; peduncle moderately long; flagellum exceeds body length slightly. Third maxilliped: long, moderately stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II about 1-¾ times longer than I, very slender; carpus, 7 segments; chelate; epipod; III longer than II, slender; epipod; IV as long as III, slender; V as long as IV, slender; III–IV, each merus with 5–7 spines; each propodus with 13–23 spinules, in 2 rows; dactyli slender, 0.27–0.36 propodi lengths. Abdomen: all somites lack median dorsal carinae; pleuron of fourth with weak ventral spine; fifth with moderate posterolateral spine; sixth somite elongate; telson, 3 pairs of dorsolateral spines; outer uropod longer than inner, both extend beyond telson.

Color Background translucent, blotches of orange scattered sparingly over most of body and appendages, darker patch on anterior branchial region of carapace; third maxilliped and pereiopods I and II with more coloring (Plate 8E).

Distinctions Distinguished from other eualids with epipods on 3 pereiopods, by arched, beaklike rostrum.

Maximum lengths Males: carapace 6.7 mm, total 29 mm; females: carapace 7.1 mm, total 44 mm.

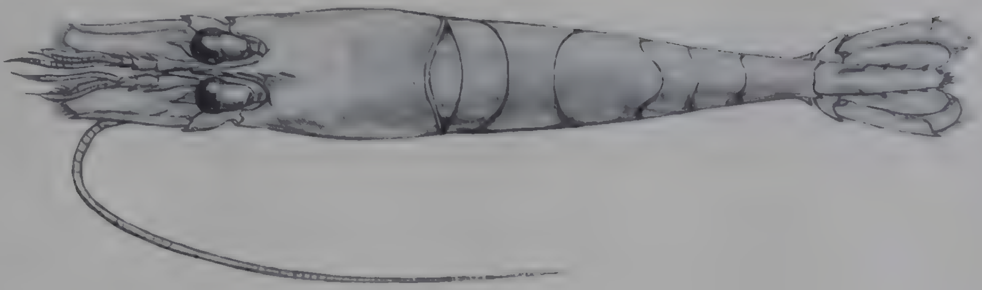
Range Pribilof Islands to Oregon; 46–642 m (219).

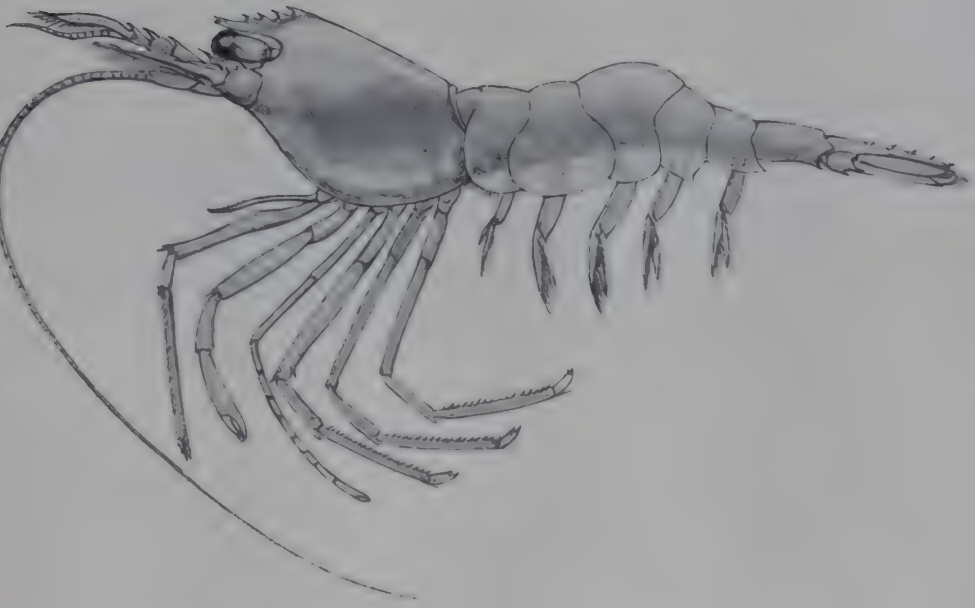
First taken in British Columbia waters by the *Albatross* Aug. 27, 1891, west of Race Rocks at 183 m (station 3445) (219).

Biology and economics This small shrimp is fairly common in the deeper waters of all coastal regions. An ovigerous female, carapace length 4.5 mm, was captured in Dixon Entrance, at 183 m, June 15, 1962. Others have been found at several localities in February, March, July, and August. The bopyrid isopod, *Hemiarthrus abdominalis*, infests *E. avinus* (225, 100).

DOLL EUALID

Eualus pusiolus (Kroyer, 1841)





Description Body fairly stout, slightly compressed. Shell thin, smooth. Rostrum short, about 0.45 carapace length, markedly descending; $\frac{2-5}{0-1}$. tip acute or bifid. Carapace spines: suborbital small, rounded; antennal strong; pterygostomian weak. Eye large, cornea well developed. Antennule: peduncle moderately long, second segment about as long as third, strong dorsal distal spine on each of 3 segments; stylocerite short; inner flagellum slightly longer than outer, both exceed antennal scale. Antenna: scale tapering, lamella exceeding spine; basicerite, 2 lateral spines; peduncle moderately long; flagellum exceeds body length somewhat. Third maxilliped: long, moderately stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, stout; merus, 1 spine; propodus, 25–41 spinules, in 2 or 3 rows; dactylus stout, about 0.25 propodus length, 6–8 spines; epipod; IV about as long as III, more slender; merus, 1 spine; propodus, 21–35 spinules, in 2 or 3 rows; dactylus stout, about 0.24 propodus length, 6 or 7 spines; V about as long as IV, as slender; merus, 0 or 1 spine; propodus, 22–30 spinules, in 2 or 3 rows; dactylus stout, about 0.22 propodus length, 6–8 spines. Abdomen: first to third somites lack spines; dorsal posterior margin of third slightly lobed; pleuron of fourth with ventral spine; pleuron of fifth with strong posterolateral spine; sixth slightly longer than fifth; with moderate posteroventral spine; telson, 3 or 4 pairs of dorsolateral spines; inner uropod equalling telson, outer slightly longer.

Color Body background mainly transparent: carapace with short, red or orange bars; spots of same color on peduncles of antennule and antenna, eyestalk, third maxilliped, and to lesser extent on proximal parts of pereiopods; also spots of same color scattered on first, third, fifth, and sixth abdominal somites, on telson, uropod, and basipodites of pleopods; light lemon spots scattered on carapace, abdomen, and appendages (Plate 7B).

Distinctions Doll eualid may be distinguished from others in this genus with epipods on 3 pereiopods, by short rostrum of normally 5 dorsal spines or fewer, which does not extend beyond eye.

Maximum lengths Males: carapace 5.0 mm, total 23 mm; females: carapace 7.0 mm, total 28 mm.

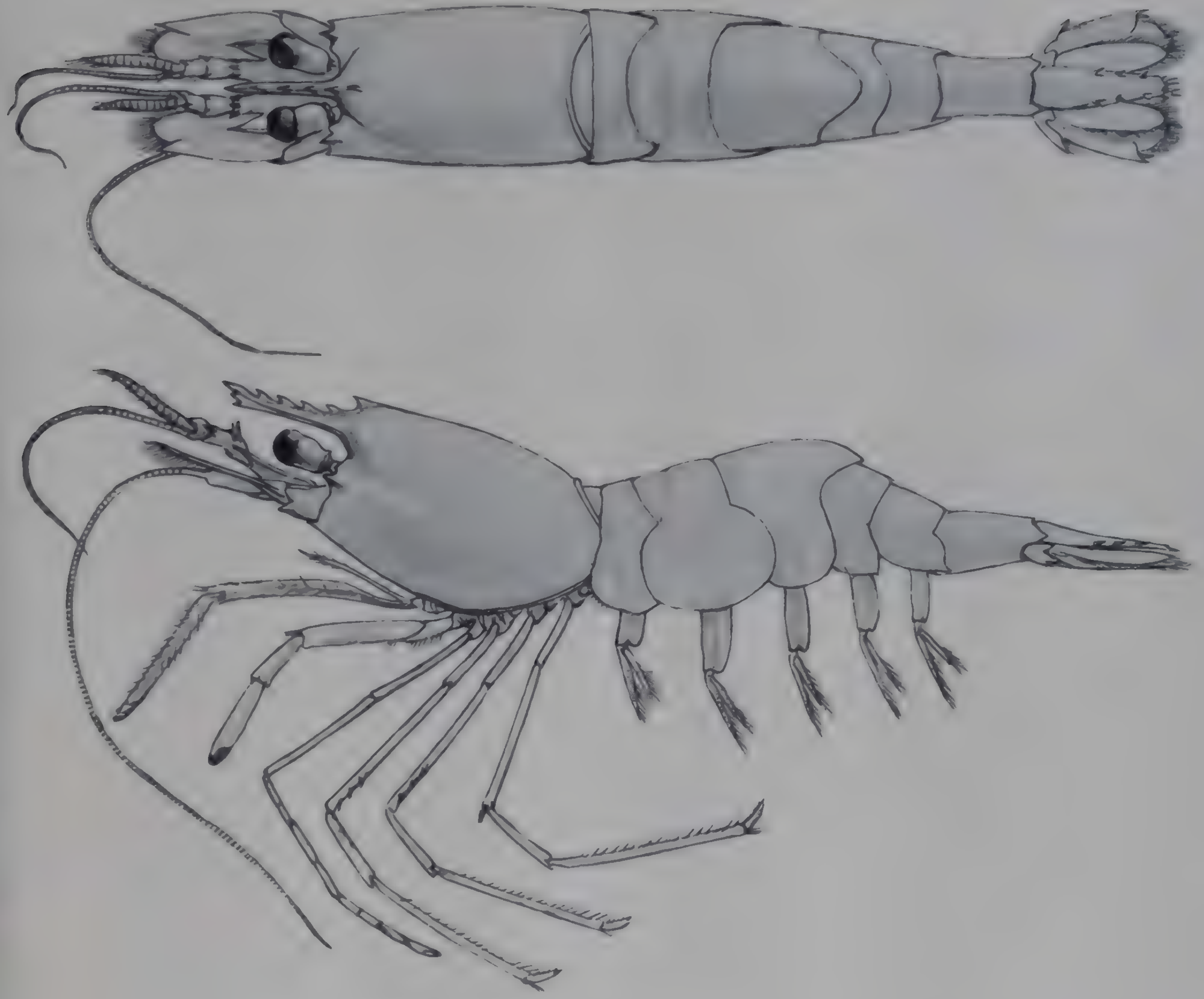
Range Chukchi Sea (265); Bering Sea to British Columbia (222); Okhotsk Sea and Sea of Japan (265); east coast of North America from Gulf of St. Lawrence to Cape Cod (247); Europe from Murman Coast to Spain (247); intertidal to 1381 m (265).

The species was recorded from British Columbia without a specific locality (222). A specimen was captured in English Bay at 55–110 m, Oct. 24, 1961.

Biology and economics The doll eualid, along with the elegant coastal shrimp, *Heptacarpus decorus*, and the blunt-bladed shrimp, *Spirontocaris truncata*, is found inside the glass sponge, *Rhabdocalyptus dawsoni*, on rocky bottom in the strait of Georgia. Off Norway the species prefers a sand bottom with algae or of fine, sandy clay (105). An ovigerous female, carapace length 3.3 mm, was caught near Saturna Island, 55–64 m, Aug. 24, 1962. Larval stages of *E. pusiolus* are known from British waters (210). In the Atlantic Ocean, this shrimp is parasitized by *Hemiarthrus abdominalis* (10).

STRIPED EUALID

Eualus herdmani (Walker, 1898)



Description Body moderately stout, somewhat compressed. Shell thin, smooth. Rostrum short, about 0.65 carapace length, slender, slightly ascending; $\frac{3-6}{1-3}$, tip acute. Carapace spines: suborbital small, rounded; antennal moderate with supporting carina; pterygostomian moderate. Eye moderately large, cornea well developed. Antennule: peduncle long, second segment a little longer than third, 3 moderate dorsal distal spines on basal segment, 2 strong spines on each of other 2 segments; stylocerite long; inner flagellum more than twice length of outer. Antenna: scale oblong, shorter than carapace, lamella slightly longer than spine; basicerite, upper lateral lobe, lower spine; peduncle moderately long; flagellum exceeds body length slightly. Third maxilliped: moderately long, stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III slightly longer than II, slender; merus, 3 spines; propodus, 16–19 spinules, in 2 or 3 rows; dactylus stout, about 0.18 propodus length, 5 spines; epipod; IV about as long as III, slender; merus, 2 or 3 spines; propodus, 15 spinules, in single row; dactylus stout, about 0.18 propodus length, 5 spines; V as long as IV, slender; merus, 0 or 1 spine; propodus, 14–22 spinules, in 1 or 3 rows; dactylus stout, about 0.18 propodus length, 4 or 5 spines. Abdomen: median dorsal margin of third somite strongly produced posteriorly; pleuron of fourth somite with weak posterolateral spine; fifth with strong posterolateral spine; sixth somite moderate length; telson moderately wide, 3 pairs dorsolateral spines; inner and outer uropod same length, reach end of telson.

Color Red diagonal lines on carapace, and first and second abdominal somites; red spots and blotches on third to sixth abdominal somites, telson, uropods, protopodites of pleopods; smaller red spots on all anterior appendages, including eye stalk and pereiopods (Plate 1C).

Distinctions Distinguished from other eualids with epipods on 3 pereiopods mainly by the rostrum, which is short, barely reaching end of sclerocerite; more or less horizontal with respect to dorsal line of the carapace; 6 or fewer widely spaced dorsal spines; little thickening in its basal part, due to widely recessed orbital margins. Another character is presence of 3 dorsal distal spines on the basal segment of antennular peduncle.

Maximum lengths Males: carapace 3.9 mm, total 20 mm; females: carapace 5.8 mm, total 25 mm.

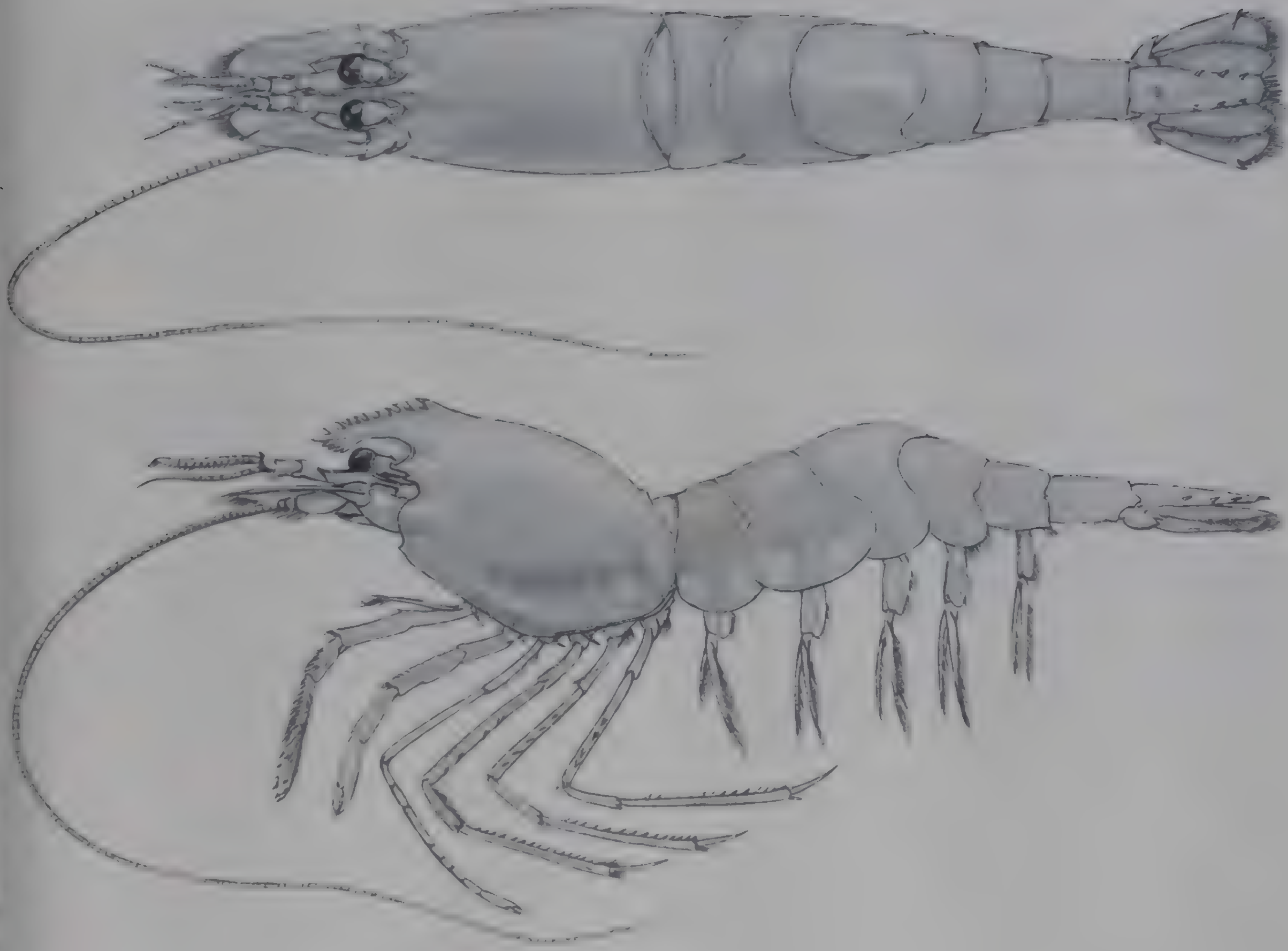
Range Sitka, AK to Puget Sound (219), 18–232 m.

First collected in British Columbia waters by A. B. Needler in Nanoose Bay at 37 m, Aug. 3, 1928.

Biology and economics This small shrimp may be caught in small numbers by trawling in Departure Bay along the west shore of Jessie Island at about 23 m. An ovigerous female, carapace length 2.6 mm, was caught there May 4, 1972. The first stage larva of the striped eualid was hatched in the laboratory (198). The species is parasitized by *Bopyroides hippolytes* (225).

BERKELEYS' EUALID

Eualus berkeleyorum Butler, 1971



Description Body moderately stout, little compressed. Shell thin, smooth. Rostrum fairly short, about 0.4 carapace length, not reaching second segment of antennular peduncle; descending; upper limb wider than lower; $\frac{8\ 11}{2\ 5}$. dorsal spines all much same size, closely and evenly spaced giving a serrated appearance, larger than ventral; tip normally acute, rarely bifid or trifid. Carapace spines: suborbital strong, pointed and slightly ascending; antennal moderately strong; pterygostomian weak, yet conspicuous. Eye moderate in size, including cornea. Antennule: peduncle moderately long, second segment longer than third; stylocerite short, almost reaching end of basal segment; inner flagellum slightly longer than outer, both extending far beyond end of antennal scale. Antenna: scale oblong, lamella exceeds spine; basicerite, upper lateral lobe, lower spine, peduncle moderately long; flagellum exceeds total body length. Third maxilliped: moderately long, stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, slender; merus, 4 or 5 spines; propodus, about 15 spinules in single row; dactylus slender, about 0.4 propodus length, 2 spines; epipod; IV shorter than III, slender; merus, 4 or 5 spines; propodus, 12–16 spinules, in single row; dactylus slender, about 0.35 propodus length, 1-5 spines; V shorter than IV, slender; merus, 4 or 5 spines; propodus, about 13 spinules, in single row; dactylus slender, about 0.33 propodus length, 1 or 2 spines. Abdomen: median dorsal margin of third somite strongly produced posteriorly; fifth somite widely recessed on posterolateral margin at articular knob; pleura of first to fourth somites rounded, fifth with posterolateral portion projected as spine; sixth somite somewhat longer than fifth, shorter than telson; telson relatively wide and robust, 3 pairs dorsolateral spines, posterior margin broadly rounded, almost truncate; inner uropod longer than outer, both extend beyond telson.

Remarks Edith Berkeley (1875–1963) and Cyril Berkeley (1878–1973), internationally known for their studies on polychaete worms, were a source of inspiration to the author.

Color Background white to cream, with red to orange patches on rostrum, other parts of carapace, and anterior appendages, including pereiopods, but most intense on third maxillipeds; also saddlelike bands of same color on abdominal somites (Plate 5A).

Distinctions Distinguished from other eualids with epipods on first 3 pereiopods by short descending rostrum armed with at least 8 closely spaced dorsal teeth, sinuous frontal margin of carapace, relatively wide telson with almost truncate posterior margin.

Maximum lengths Males: dimensions unknown; females: carapace 9.8 mm, total 38 mm.

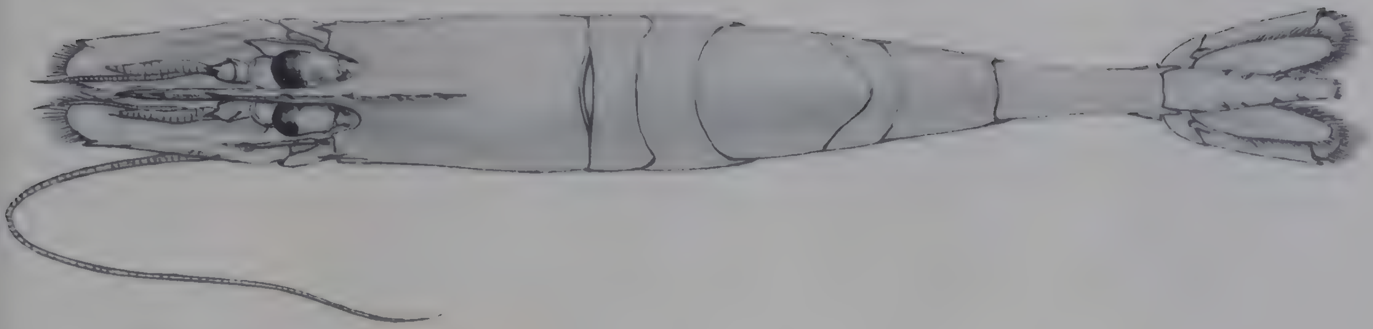
Range British Columbia coast, Chatham Sound to Vancouver Island; 46–384 m (61).

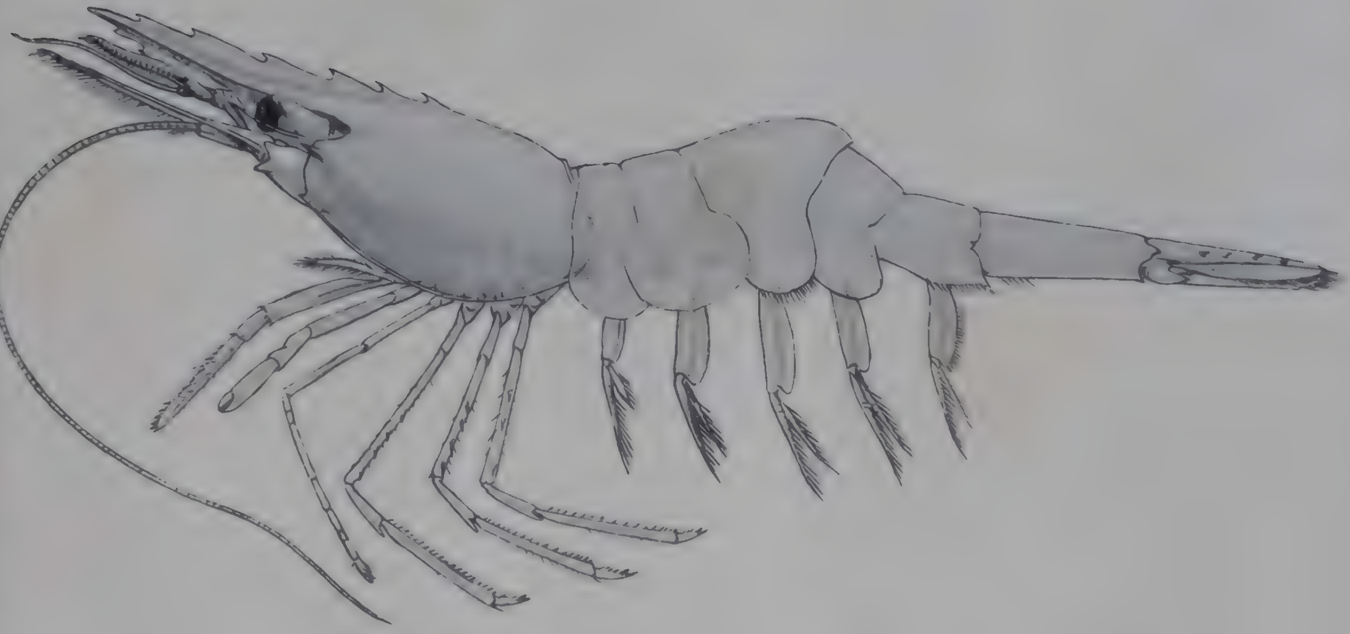
First taken in British Columbia waters by *Investigator No. 1* near Gabriola Island in the Strait of Georgia, 384 m, Dec. 3, 1963 (61).

Biology and economics Berkeleys' eualid occurs mainly on a soft mud bottom, and catch records show a tendency for larger individuals to inhabit deeper water. One specimen, carapace length 5.0 mm, from near Comox Bar was parasitized by the isopod parasite, *Hemiarthrus abdominalis* (61). Another female, carapace length 6.9 mm, from the same locality, when captured May 22, 1969, had a few eyed eggs attached to the pleopods. The male of this species has yet to be found.

TOWNSEND'S EUALID

Eualus townsendi (Rathbun, 1902)





Description Body moderately stout, somewhat compressed. Shell thin, smooth. Rostrum moderately long, 1.2–1.3 carapace length, distal half slightly ascending, upper limb narrower than lower, $\frac{5\text{-}7}{3\text{-}6}$, tip acute. Carapace spines: suborbital weak, rounded; antennal strong; pterygostomian weak. Eye moderately large, cornea well developed. Antennule: peduncle moderately long, second segment about as long as third, a strong dorsal distal spine on each of second and third segments; stylocerite moderately long; inner flagellum a little longer, and outer shorter than antennal scale. Antenna: scale exceeds carapace length, tapering slightly, lamella exceeds spine; basicerite, 2 blunt lateral spines; peduncle short; flagellum about equal to body length. Third maxilliped: short, stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III longer than II, a little stouter; merus, 4 or 5 spines; propodus, about 20 spinules in single row; dactylus moderately stout, about 0.25 propodus length, 4 or 5 spines; IV as long as III, slender; merus, 3 or 4 spines; propodus, 16–19 spinules in single row; dactylus moderately stout, about 0.33 propodus length, 6 or 7 spines; V a little longer than IV, slender; merus, 1–3 spines; propodus, about 15 spinules in single row; dactylus moderately stout, about 0.24 propodus length, 5 or 6 spines. Abdomen: first to fourth somites lack spines; dorsal posterior margin of third slightly lobed; pleuron of fifth with moderately strong posterolateral spine, sixth elongate with moderate posteroventral spine; telson 4 pairs of lateral spines; outer uropod as long as telson, inner somewhat shorter.

Remarks C. H. Townsend was a naturalist on the *Albatross*.

Color Translucent, with cardinal red spots in loose groups over entire body; light cream on rostrum, third maxillipeds, and distal ends of protopodites of pleopods, telson, and inner uropod; distal spines of third maxilliped black, also fingers of pereiopod I, and dactyli of pereiopods III, IV, and V (Plate 8C).

Distinctions Townsend's eualid is the only British Columbia member of the genus that normally has epipods of full size on only third maxillipeds and first 2 pereiopods. Resembles short-scaled eualid closely, but lacks a ventral spine on pleuron of fourth abdominal somite, and antennal scale is longer than carapace.

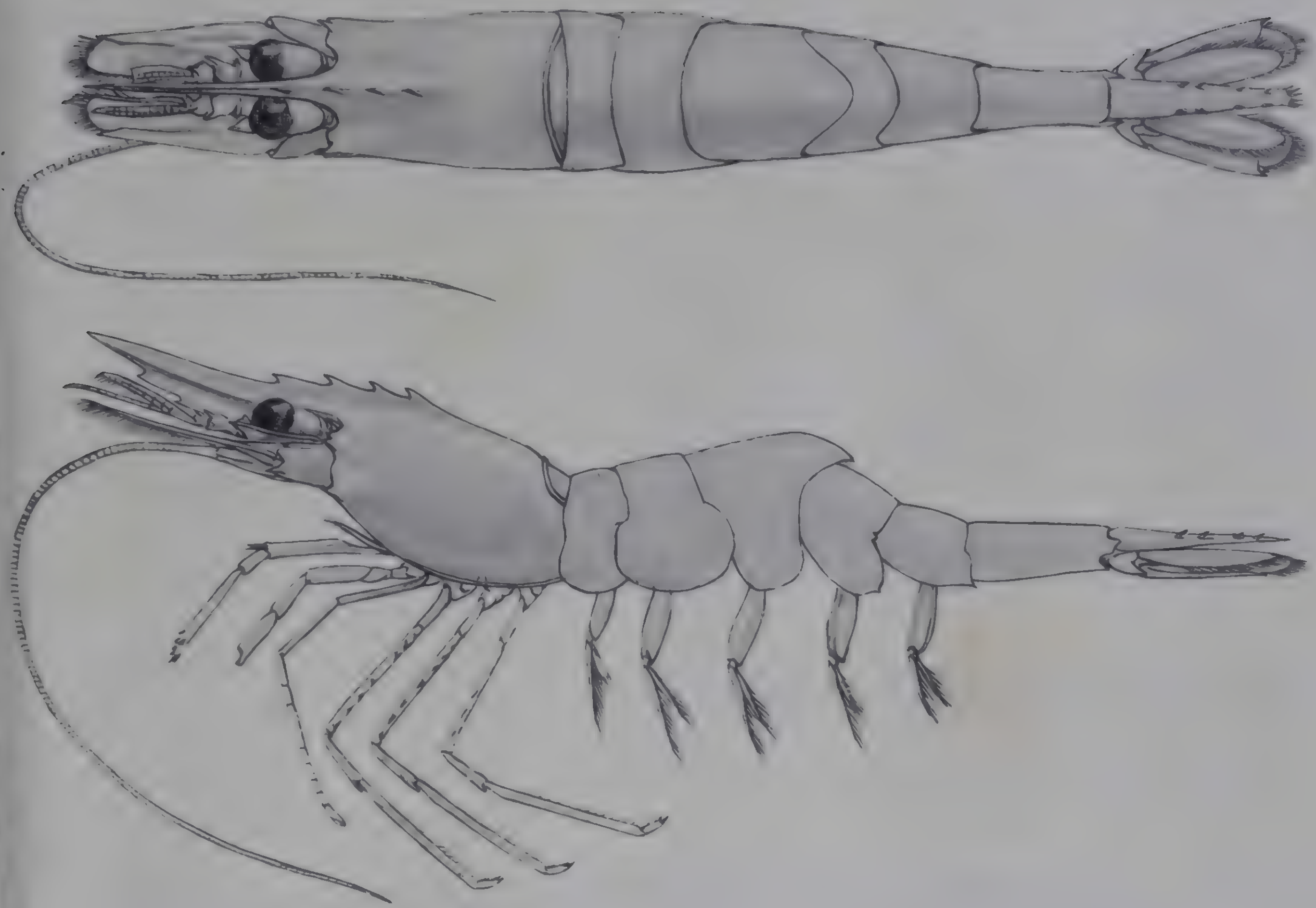
Maximum lengths Males: carapace 5.2 mm, total 35 mm; females: carapace 7.7 mm, total 44 mm.

Range Pribilof Islands to Puget Sound (219); Sea of Japan and Okhotsk Sea; 38–630 m (219, 265). First taken in British Columbia waters by the *Albatross* Aug. 31, 1888, in Queen Charlotte Strait at 435 m (station 2862) (219).

Biology and economics It appears that this shrimp is less common in coastal inlets than the short-scaled eualid. Townsend's eualid is a host of the isopod, *Hemiarthrus abdominalis* (225, 100).

ARCTIC EUALID

Eualus fabricii (Krøyer, 1841)



Description Body slender, somewhat compressed. Shell thin, smooth. Rostrum moderately long, about 1.3 carapace length, ascending slightly, upper limb narrower than lower, $\frac{2\ 6}{1\ 5}$. dorsal spines not extending beyond eye, tip acute. Carapace spines: suborbital small, rounded; antennal moderate; pterygostomian moderate. Eye moderately large, cornea well developed. Antennule: peduncle short, second segment longer than third, both with dorsal spines; stylocerite moderately long; inner flagellum slightly longer than antennal scale, outer shorter. Antenna: scale oblong, lamella exceeding spine; basicerite, upper lateral lobe, lower spine; peduncle short; flagellum about equal to body length. Third maxilliped: moderately long, moderately stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; exopod; epipod; III longer and stouter than II; merus, 7 spines; propodus, about 20 spinules in single row; dactylus moderately stout, about 0.26 propodus length, 6 spines; IV shorter than III, as stout; merus, 4 or 7 spines; propodus, about 15 spinules; dactylus moderately stout, about 0.25 propodus length, 6 spines; V as long as IV, slender; merus, 3 or 4 spines; propodus, about 12 spinules in single row; dactylus moderately stout, about 0.28 propodus length, 5 spines. Abdomen: median dorsal margin of third strongly produced posteriorly; pleuron of fourth with moderate lateral spine; fifth with weak posterolateral spine; sixth elongate; telson, 4 or 5 pairs of lateral spines; inner uropod shorter than telson, outer slightly longer.

Remarks Counts of spines on telson and meri of pereiopods show wide variation on Atlantic specimens (166). Numbers given above are based on relatively few Pacific specimens examined.

Color White background spotted with deep bright red over entire body, but with red bars or rings on third maxilliped, pereiopods, and first pleopod (166).

Distinctions Distinguished from other eualids by well-developed, knifelike rostrum, without dorsal spines ahead of the eyes.

Maximum lengths Males: carapace 4.3 mm, total 27 mm; females: carapace 7.5 mm, total 42 mm.

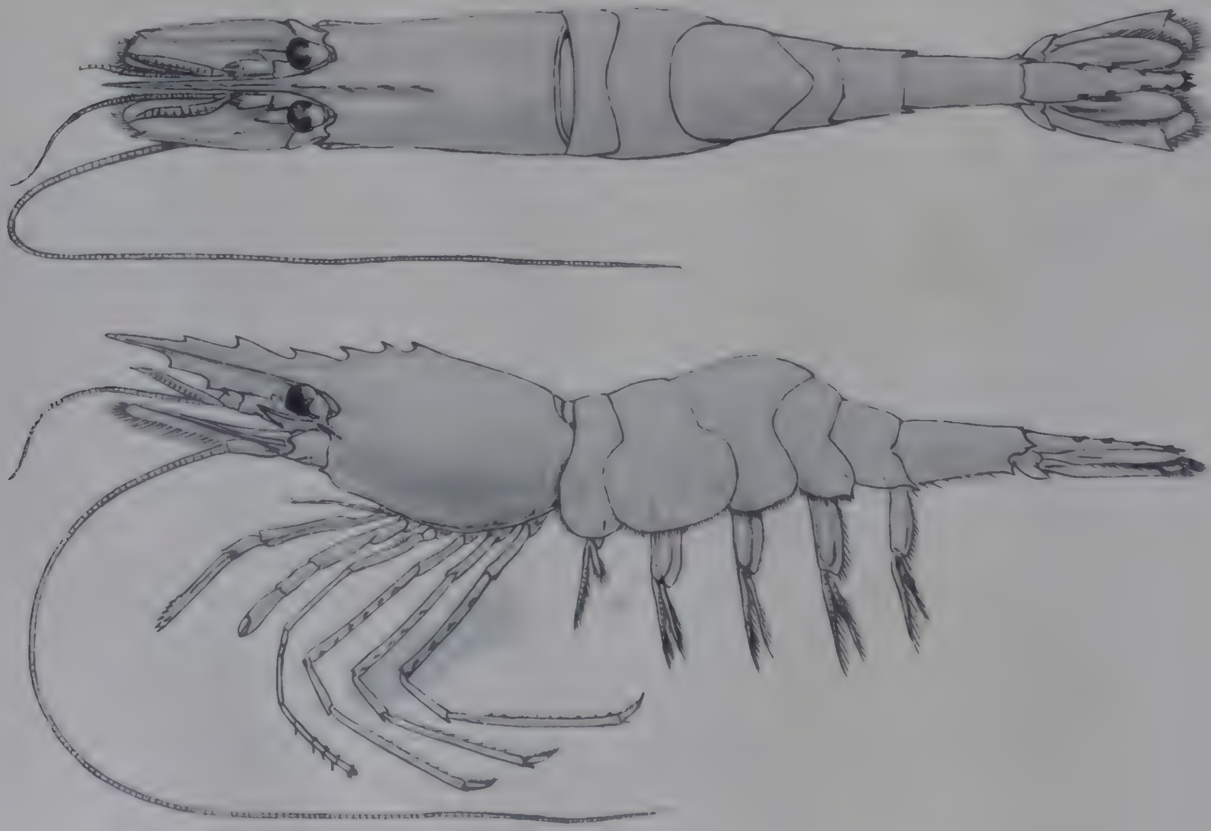
Range Chukchi Sea (266); Bering Sea to British Columbia (222); Sea of Japan and Okhotsk Sea (266); in northwest Atlantic Ocean, from Foxe Basin and west Greenland to Massachusetts Bay; 4–255 m (247).

The species was recorded from British Columbia (222), but no specific locality was given. A female was caught in Namaimo Harbour, at 15 m, June 14, 1973.

Biology and economics This species appears to be the least abundant of the local eualids. Most females collected off Newfoundland and Labrador were ovigerous in May and June as well as in October and November (247). Characters of the later larval stages were summarized (210). The isopod parasites *Hemiarthrus abdominalis* and *Bopyroides hippolytes* are found on the Arctic eualid (225, 100).

SHORT-SCALED EUALID

Eualus suckleyi (Stimpson, 1864)



Description Body slender, somewhat compressed. Shell thin, smooth. Rostrum moderately long, 1.0–1.3 carapace length, distal half slightly ascending, upper limb narrower than lower, $\frac{5-7}{3-5}$, tip acute. Carapace spines: suborbital weak, rounded; antennal strong; pterygostomian weak. Eye moderately large, cornea well developed. Antennule: peduncle short, second segment much longer than third; stylocerite long; inner flagellum about twice length of outer, which extends to end of antennal scale. Antenna: scale shorter than carapace length, tapering slightly, lamella exceeding spine; basicerite, 2 lateral spines; peduncle short; flagellum slightly shorter than body length. Third maxilliped: short, stout; exopod; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; normal epipod normally present; II longer than I, slender; carpus, 7 segments; chelate; epipod of reduced size sometimes present; III longer than II, moderately stout; merus, 5–9 spines; propodus, 12–14 spines in single row; dactylus moderately stout, about 0.26 propodus length, 6–8 spines; IV as long as III, moderately stout; merus, 5 or 6 spines; propodus, 11–15 spines in single row; dactylus moderately stout, about 0.26 propodus length, 6–8 spines; V slightly longer than IV, moderately stout; merus, 2–4 spines; propodus, 9–14 spines in single row, dense tuft of setae at distal end; dactylus moderately stout, about 0.22 propodus length, 6–8 spines. Abdomen: first to third somites lack spines; dorsal posterior margin of third slightly lobed; pleuron of fourth with ventral spine; pleuron of fifth with strong posterolateral spine; sixth elongate with moderate posteroventral spine; telson, 4 pairs dorsolateral spines; outer uropod longer than inner, both shorter than telson.

Color Background whitish or neutral tone; bands and blotches of red speckling distinct over whole body, denser on appendages; pronounced irregular whitish markings on carapace (Plate 1A).

Distinctions The short-scaled eualid usually lacks an epipod on the second pereiopod and differs from the Arctic eualid by dorsal spines on distal half of the rostrum. It may be distinguished from Townsend's eualid, if the status of epipods is in doubt, by presence of lateral spine on pleuron of fourth abdominal somite, and shorter antennal scale.

Maximum lengths Males: carapace 8.8 mm, total 48 mm; females: carapace 12.7 mm total, 79 mm.

Range Chukchi Sea (266); Bering Sea to about Grays Harbor off Washington (219); Okhotsk Sea (266); 11–1025 m (37).

First taken in British Columbia waters by the *Albatross* Aug. 27, 1891, west of Race Rocks at 183 m (station 3445) (219).

Biology and economics This eualid is fairly common in British Columbia inlets. An ovigerous female, carapace length 10.1 mm, was trawled in Burke Channel, 249 m, May 18, 1964. Three isopod parasites, *Hemiarthrus abdominalis* (225, 100), *Bopyroides hippolytes* (225, 100), and *Argeia pugettensis* (100) infest *E. suckleyi*. In Alaskan waters the average estimate of egg numbers obtained by partial counts from 5 ovigerous females was 1450 (137).

Genus *Heptacarpus* Holmes, 1900

Rostrum armed, conspicuous or inconspicuous. Mandible with incisor process and palp of two segments. Eye well developed, with or without keel-shaped ridge on inner margin of stalk. Third maxilliped without exopod, with or without epipod. Epipods absent or present on first to third pereiopods. Carpus of second pereiopod with seven segments. Ventral spine of pleuron of third abdominal somite present, or absent.

The presence or absence of a ventral spine on pleuron of the fourth somite, although mentioned in earlier descriptions, has not been used as a character for identification. Among the 13 species of the genus recorded locally, 6 have the spine. It has, therefore, been a useful character in the construction of a key. Another character, apparently not reported previously, is the keel-shaped ridge on the inner margin of the eyestalk; externally, it differs from the conical or spiniform process seen on eyestalks of most species of the genus *Spirontocaris.* Its function and taxonomic importance are unknown. All local species of *Heptacarpus* except *H. stimpsoni* have bifid tips on dactyli of the third to fifth pereiopods.

It is likely that two additional species of the genus will be found in the future in British Columbia waters. *H. flexus,* which ranges from the Bering Sea to California (219) and occurs in the San Juan Islands (159), is included in the key below. The other species, *H. taylori* (Stimpson, 1857), is known from California (232) and the San Juan Islands (159). Not included in the present key, it can, however, be distinguished from locally occurring shrimps of the genus with a ventral spine on the fourth pleuron and epipods on the first three pereiopods (in particular *H. brevirostris*), by the very short rostrum, not reaching the tip of the cornea of the eye; the antennal scale much shorter than the telson; the slender third maxillipeds, when extended, reaching or slightly exceeding the tip of the antennal scale; and, the bifid tips on dactyli of the third to fifth pereiopods.

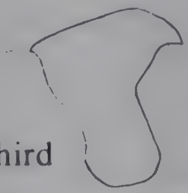
Members of the genus are small- to medium-sized shrimps, inhabiting the littoral and continental shelf zones. All known species occur in the North Pacific Ocean and adjacent seas. One, *H. pandaloides,* was recorded from the Indus River mouth, as well as in the Yellow Sea and the Sea of Japan (129). In this Bulletin, species of *Heptacarpus* are termed "coastal shrimps."

Key to species of genus *Heptacarpus*

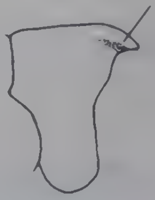
1	Ventral margin of fourth pleuron without spine	2
	Ventral margin of fourth pleuron with spine	9
2	Epipod absent on third maxilliped	Slender coastal shrimp, *H. tenuissimus* (p. 208)
	Epipod present on third maxilliped	3
3	Two or 3 pereiopods with epipods	4
	All pereiopods without epipods	5
4	Epipods present on first and second pereiopods	[*H. flexus* (Rathbun, 1902)]
	Epipods present on first to third pereiopods	Small-eyed coastal shrimp, *H. carinatus* (p. 210)
5	Pterygostomian spine absent	Stiletto coastal shrimp, *H. stylus* (p. 212)
	Pterygostomian spine present	6
6	Antennal scale shorter than carapace; sixth somite longer than telson	Elegant coastal shrimp, *H. decorus* (p. 214)
	Antennal scale as long as or longer than carapace; sixth somite shorter than telson	7

7 Three spines on carapace and rostrum, none anterior to eye; third somite with prominent dorsal posterior lobe, deep groove on each side .... Three-spined coastal shrimp, *H. tridens* (p. 215)

Five to 6 spines on carapace and rostrum, extending anterior to eye 8



8 Dorsal posterior margin of third abdominal somite prominent; third maxilliped extending to middle of antennal scale .... Northern coastal shrimp, *H. camtschaticus* (p. 217)



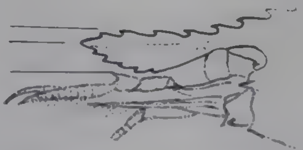
Dorsal posterior margin of third abdominal somite flattened; third maxilliped extending almost to end of scale .... Kincaid's coastal shrimp, *H. kincaidi* (p. 218)

9 Epipod on only first pereiopod 10

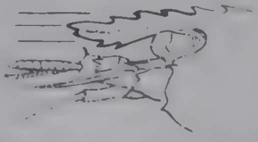
Epipods on only first and second, or on first to third pereiopods 12

10 Pterygostomian spine absent .... Large-eyed coastal shrimp, *H. littoralis* (p. 220)

Pterygostomian spine present 11



11 Outer antennular flagellum extending beyond antennal scale by about half length of former; lower limb of rostrum broader than upper .... Alaska coastal shrimp, *H. moseri* (p. 223)

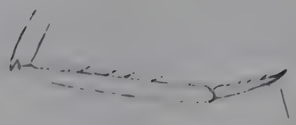


Outer antennular flagellum barely extending beyond antennal scale; lower limb of rostrum scarcely broader than upper .... Common coastal shrimp, *H. sitchensis* (p. 225)

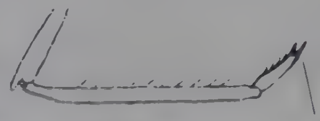
12 Epipods on first and second pereiopods .... California coastal shrimp, *H. paludicola* (p. 227)

Epipods on first to third pereiopods 13

13 Rostrum normally with ventral spines; simple tips on dactyli of third to fifth pereiopods .... Stimpson's coastal shrimp, *H. stimpsoni* (p. 229)

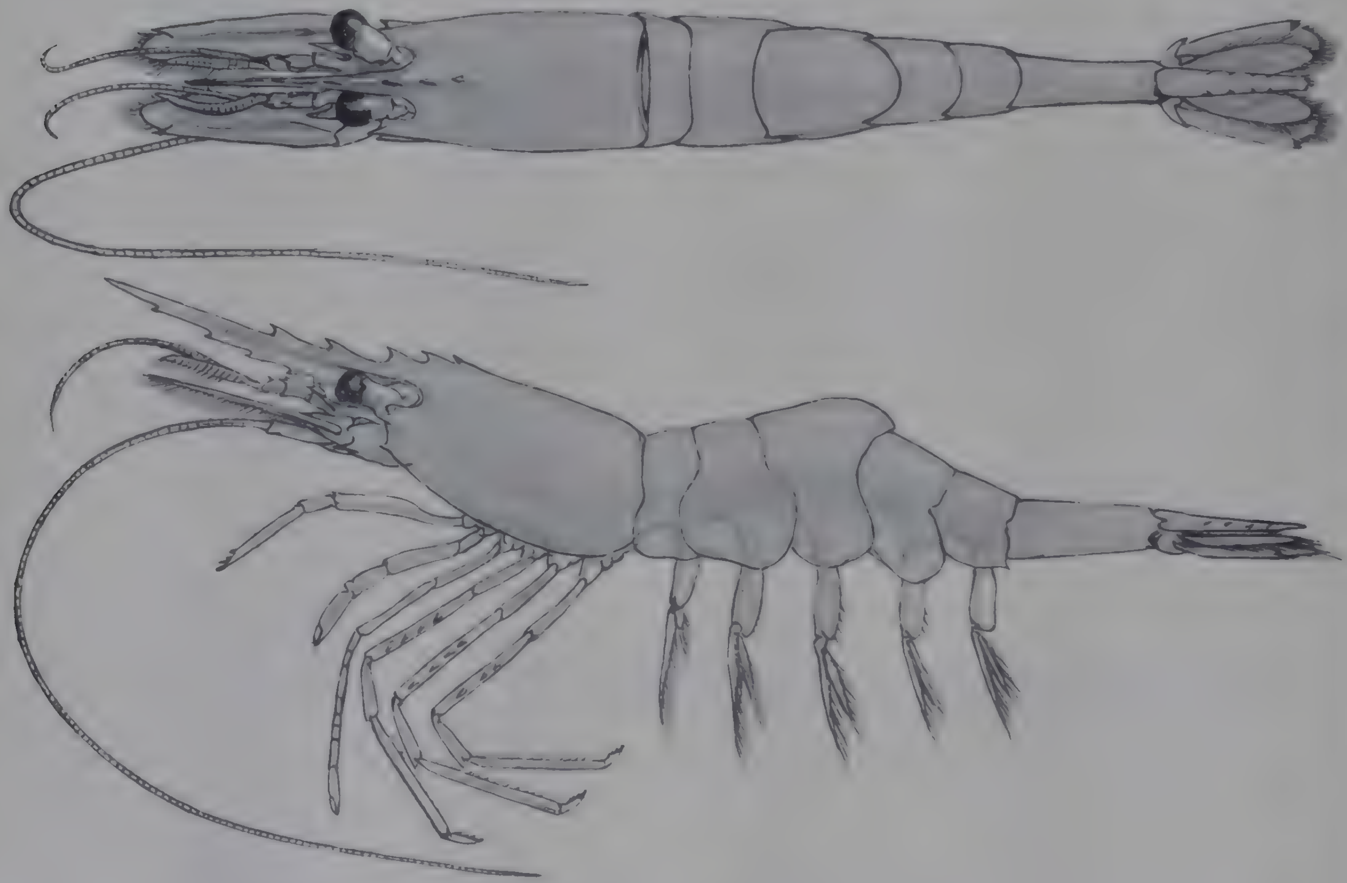


Rostrum normally without ventral spines; bifid tips on dactyli of third to fifth pereiopods .... Stout coastal shrimp, *H. brevirostris* (p. 231)



SLENDER COASTAL SHRIMP

Heptacarpus tenuissimus Holmes, 1900



Description Body slender, moderately compressed. Shell thin, surface smooth. Rostrum moderately long, 1.3–1.4 carapace length, lower limb wider than upper, slightly ascending, $\frac{4-5}{4-8}$, tip acute. Carapace spines: suborbital moderate, rounded; antennal moderate to strong; pterygostomian moderate. Eye moderate, cornea well developed. Antennule: peduncle moderately long, third segment subequal to second, dorsal distal spine on both; stylocerite moderately long; inner flagellum about twice length of outer, and as long as carapace, outer not reaching end of antennal scale, setiferous. Antenna: scale longer than telson, slender, lamella exceeding spine considerably; basicerite, upper lateral lobe, lower strong spine; peduncle short; flagellum as long as body. Third maxilliped: moderately long, moderately stout. Pereiopods: I shorter than third maxilliped, stout; chelate; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, a little stouter; merus, 3 or 4 spines; propodus, 22–24 spinules, 1 or 2 rows; dactylus moderately stout, about 0.25 propodus length, 5–7 spines, bifid; IV longer than III, as slender; merus, 4 spines; propodus, about 25 spinules, 1 or 2 rows; dactylus moderately stout, about 0.2 propodus length, 5–7 spines, bifid; V shorter than IV, as slender; merus, 2 or 3 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus stout, about 0.2 propodus length, 5–7 spines, bifid. Abdomen: most of ventral margins of pleura of first and second somites straight, or slightly concave; posterior dorsal margin of third produced moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with strong posterolateral spine; sixth shorter than telson, slender, moderate posteroventral spine; telson narrow, tapering to acute tip, 4 pairs dorsolateral spines; inner uropod reaching or exceeding end of telson, outer somewhat longer.

Color Unavailable.

Distinctions Separated from all other coastal shrimps by absence of epipod on each of third maxilliped and pereiopod I; also lacks ventral spine on pleuron of fourth abdominal somite. Other characters are antennal scale longer than telson, and slender sixth abdominal somite.

Maximum lengths Males: carapace 6.6 mm, total about 36 mm; females: carapace 7.7 mm, total, 43 mm.

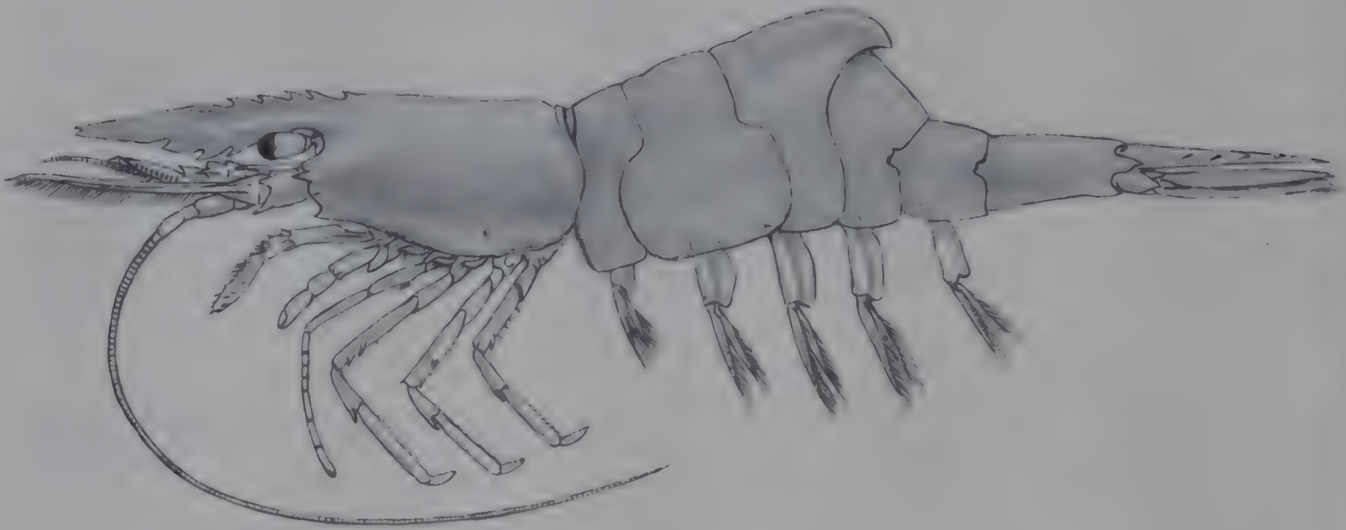
Range Bird Island, AK (219), to Santa Catalina Island, CA (232), 2–137 m (290).

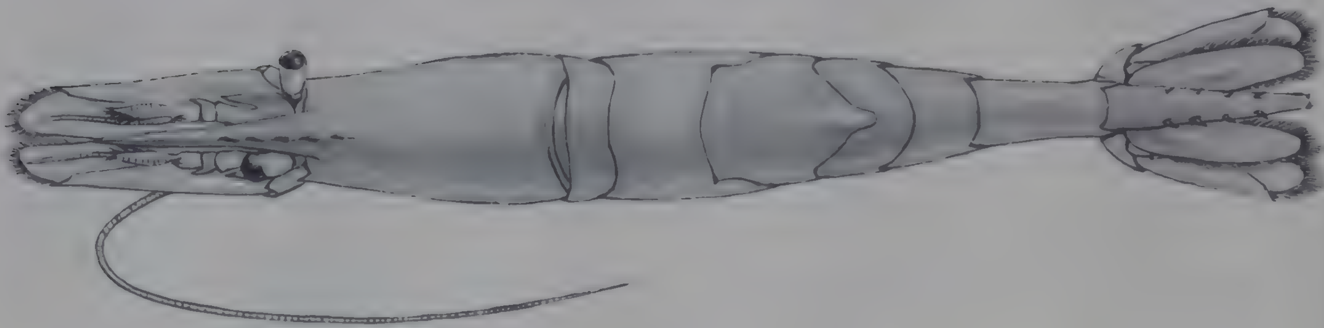
First taken in British Columbia waters by the *Albatross* Sept. 25, 1888, northwest of Barkley Sound at 62 m (station 2879) (219).

Biology and economics This species is fairly common in Departure Bay where it has been caught along with *Hippolyte clarki* and *Heptacarpus brevirostris.* Ovigerous females, 5.5–7.7 mm carapace length, have occurred at several coastal localities in February, May, and July. It is parasitized by *Hemiarthrus abdominalis* (100).

SMALL-EYED COASTAL SHRIMP

Heptacarpus carinatus Holmes, 1900





Description Body moderately stout, little compressed. Shell thin, surface smooth. Rostrum moderately long, 0.9–1.2 carapace length, horizontal over eyes, rest descending, $\frac{3-7}{2-6}$, tip acute. Carapace spines: suborbital moderate, rounded; antennal strong; pterygostomian moderate. Eye small, stalk slender, cornea well developed. Antennule: peduncle moderately long, third segment about as long as second, dorsal distal spine on each; stylocerite short, broad at base; outer flagellum very short, setiferous, inner not normally extending beyond antennal scale. Antenna: scale normally longer than carapace, lamella greatly exceeds spine; basicerite, 2 lateral spines, lower stronger; peduncle short; flagellum about as long as body. Third maxilliped: short, stout; epipod. Pereiopods: I shorter than third maxilliped, as stout; lamina on each of basis and ischium; chelate; epipod; II longer than I, slender; ischium with slight lamina; carpus, 7 segments; chelate; epipod; III longer than II, moderately stout; merus, 1–3 spines; propodus, 26–34 spinules, 2 or 3 rows; dactylus stout, about 0.27 propodus length, 5 or 6 spines, bifid; epipod; IV longer than III, slightly stouter; merus, 0–2 spines; propodus, 24–35 spinules, 2 or 3 rows; dactylus stout, about 0.3 propodus length, 4–6 spines, bifid; V as long as IV, as stout; merus, 1 spine; propodus, 30–39 spinules, 2 or 3 rows; dactylus moderately stout, about 0.37 propodus length, 5 or 6 spines, bifid. Abdomen: in females, pleura of first somites considerably deeper than ventral margin of carapace, less so in males; ventral margins of pleura of first 3 somites straight, or very slightly convex; a short, shallow, transverse sulcus on dorsal surface of each of second and third somites; dorsal posterior margin of third strongly lobed and compressed;

posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with weak posterolateral spine; sixth with weak posteroventral spine; telson moderately wide, tapering to rounded tip, 2–5 pairs lateral spines; inner and outer uropod about same length, not reaching tip of telson.

Color Specimens from Yakan Point fairly translucent; apple green over most of body, with entire rostrum brick red; 2 thin median dorsal red stripes originating at base of rostrum, extending posteriorly over carapace to sixth abdominal somite. Color pattern less pronounced on small specimens. Those collected in California among green seaweeds were uniformly bright green, others found nearby in red algae were almost exactly the color of these algae (128).

Distinctions *H. carinatus* is the only known local coastal shrimp that lacks a ventral spine on the pleuron of the fourth abdominal somite, and has epipods on pereiopods I–III. Other identifying characters are the wide, bladelike rostrum, lacking spines in distal half; small eyes; beaklike projection of dorsal posterior margin of third abdominal somite; deep pleura of first 3 abdominal somites with mainly straight ventral margins.

Maximum lengths Males: carapace 5.0 mm, total 38 mm; females: carapace 10.0 mm, total, 51 mm.

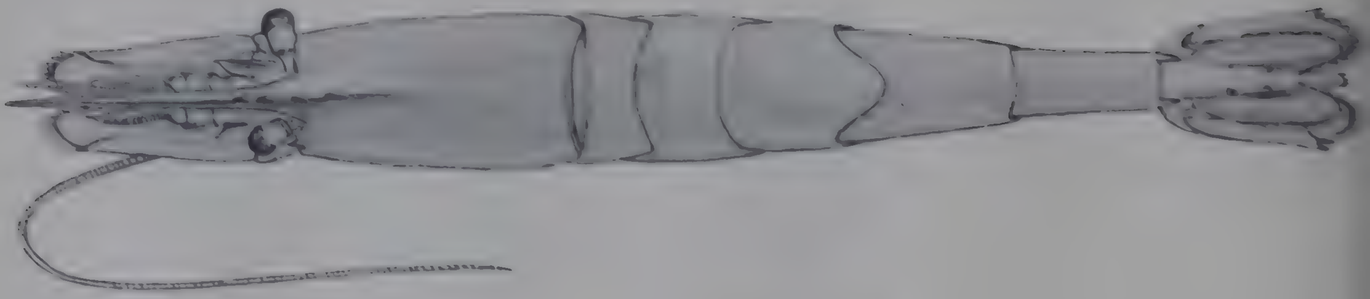
Range Dixon Harbor, southeastern Alaska (250, 43), to Point Loma (219); intertidal to 27 m (129).

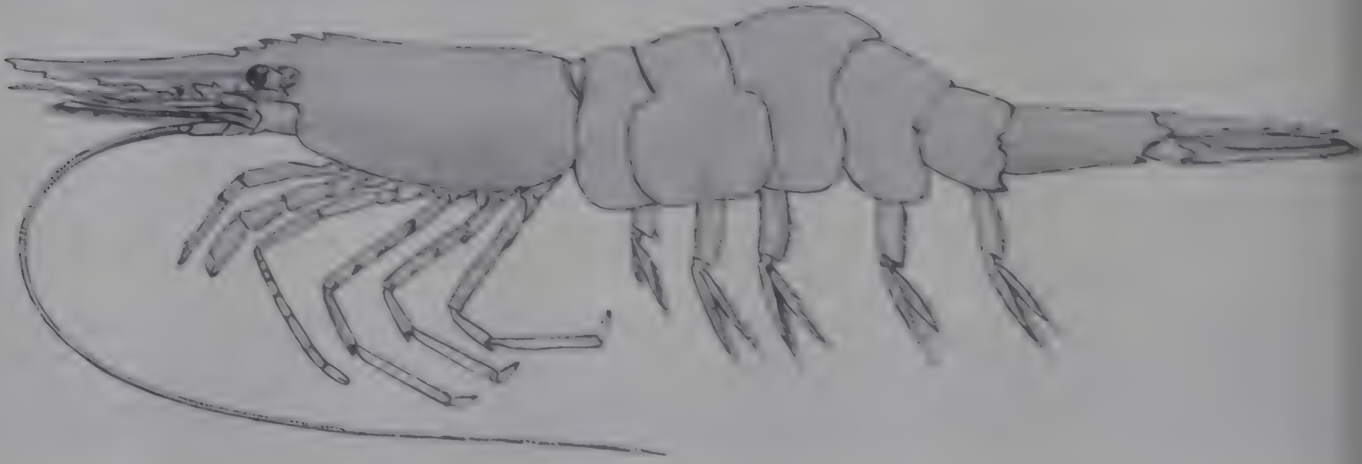
First known record in British Columbia waters, at Yakan Point, northern end of Queen Charlotte Islands, in tide pool, July 28, 1949.

Biology and economics This shrimp has been collected along the exposed coast mainly in tide pools, where it lives among eelgrass and algae. Collecting in tide pools at 4 localities in southeastern Alaska yielded 4 males, and 21 females, including 3 ovigerous specimens (250, 43). Associated species were *Heptacarpus brevirostris, H. sitchensis, H. stylus, Hippolyte clarki, Pandalus platyceros,* and *P. danae.*

STILETTO COASTAL SHRIMP

Heptacarpus stylus (Stimpson, 1864)





Description Body moderately stout, little compressed abdomen deeper than carapace. Shell thin, surface smooth. Rostrum moderately long, 1.1–1.4 carapace length, styliform, a little arched over eye, horizontal, $\frac{3-4}{3-5}$, tip acute. Carapace spines: suborbital moderate, rounded; antennal strong. Eye small, cornea well developed. Antennule: peduncle moderately long, third segment subequal to second, dorsal distal spine on each of second and third segments; stylocerite short; inner flagellum about twice length of outer, former exceeds antennal scale, outer setiferous. Antenna: scale longer than telson, lamella exceeding spine considerably; basicerite, with upper lateral lobe, and lower strong spine; peduncle short; flagellum longer than body. Third maxilliped: short, moderately stout; epipod. Pereiopods: I about as long as third maxilliped, stout; chelate; II longer than I, slender; carpus, 7 segments, widens distally; chelate; III longer than II, a little stouter; merus, 3 or 4 spines; propodus, about 15 spinules, 1 or 2 rows; dactylus stout, about 0.25 propodus length, 4 spines, bifid; IV shorter than III, as stout; merus, 3 spines; propodus, about 16 spinules, 1 or 2 rows; dactylus stout, about 0.27 propodus length, 4 spines, bifid; V slightly shorter than IV; as stout; merus, 3 spines; propodus, about 13 spinules, 1 or 2 rows; dactylus stout, about 0.28 propodus length, 4 spines, bifid. Abdomen: most of ventral margins of pleura of first and second somites straight or slightly concave; anterior dorsal parts of second and third somites with short, faint transverse sulci; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with strong posterolateral spine; sixth slender, shorter than telson, with moderate posteroventral spine and lobe above; telson narrow, tapering to rounded tip, 3 pairs dorsolateral spines; inner uropod reaching end of telson, outer longer, exceeds telson slightly.

Color Background pale amber; fine olive-brown dots cover carapace fairly evenly, also most of abdomen, except lower parts of first, second, third, and fifth pleura; dorsal spines on rostrum and carapace light green; pattern of blue spots, 6 on lateral surface of carapace, 2 on first somite, 1 near posterior margin of second somite, 3 fine dots in line on eyestalk; pleopods, third maxilliped, and pereiopods milkish, latter with stripes and spots of pale red amber mainly on proximal segments; same color on distal parts of telson and uropods; also eyestalk, antennal scale, and outer flagellum of antennule; inner flagellum and antennal flagellum transparent. Occasionally, predominant coloration dark red or kelp brown, but pattern of blue spots the same (Plate 6B). In Parry Bay, in shallow water among brown algae *Laminaria* and *Nereocystis* and sea lettuce *Ulva,* transparent with kelp-brown tinge and varying amounts of fine red spotting (109).

Distinctions Distinguished from other coastal shrimps lacking a ventral spine on pleuron of fourth abdominal somite, and without an epipod on any pereiopod, by absence of pterygostomian spine, relatively small eyes, and short, faint transverse sulcus on each of anterior dorsal surfaces of second and third abdominal somites.

Maximum lengths Males: carapace 7.3 mm, total 40 mm; females: carapace 11.0 mm, total 57 mm.

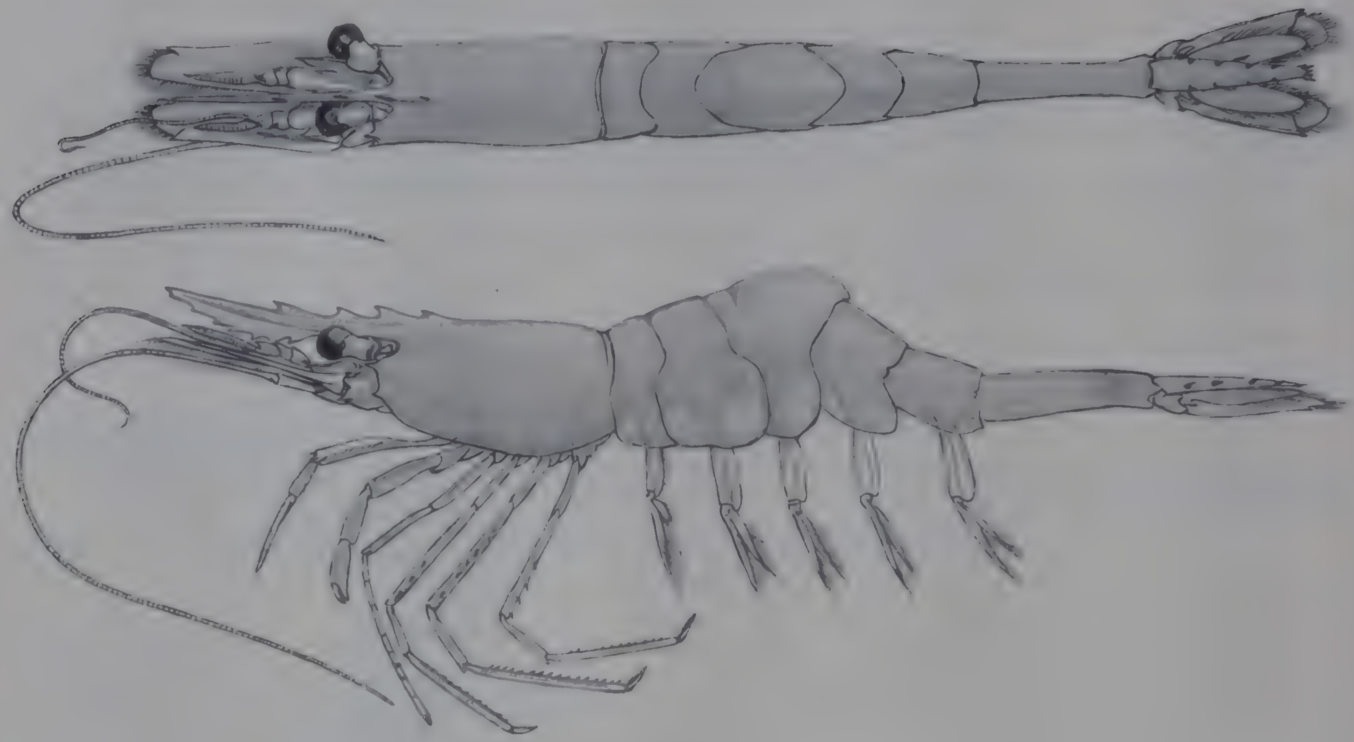
Range Chichagof Island, AK (250, 43) to Puget Sound; intertidal to 439 m. This maximum depth was at a station in the Strait of Georgia where 9 specimens were collected by bottom trawling Dec. 4, 1963.

First collected in British Columbia waters by J. K. Lord in Esquimalt Harbour in 1862, and recorded as a new species, *Hippolyte esquimaltiana* Bate (25).

Biology and economics *H. tridens* is a fairly common local species, especially in intertidal and sublittoral zones around southern Vancouver Island. As stated above, it has a considerable bathymetric range. Ovigerous females, 5.3–9.8 mm carapace length, were taken at several localities in February, March, April, May, August, and December.

ELEGANT COASTAL SHRIMP

Heptacarpus decorus (Rathbun, 1902)



Description Body slender, greatly compressed. Shell thin, surface smooth. Rostrum moderately long, 1.1–1.4 carapace length, lower limb wider than upper, slightly ascending, $\frac{4-5}{4-8}$, tip acute. Carapace spines: suborbital weak, rounded; antennal strong; pterygostomian strong. Eye moderate, cornea well developed, keellike ridge on inner margin of stalk. Antennule: peduncle short, second and third segments about equal, dorsal distal spines on both but stronger on third; stylocerite short; inner flagellum about 4 times length of outer and longer than carapace. Antenna: scale as long as carapace, lamella tapering, exceeds spine; basicerite with 2 lateral spines; peduncle short; flagellum shorter than body. Third maxilliped: moderately long, moderately stout; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, little stouter; merus, 3–5 spines; propodus, about 20 spinules, 1–3 rows; dactylus moderately stout, about 0.24 propodus length, 5 or 6 spines, bifid; IV longer than III; slightly stouter; merus, 4 spines; propodus, about 20 spinules, 1–3 rows; dactylus slender, about 0.22 propodus length, 5 or 6 spines, bifid; V shorter than IV, as stout; merus, 3 or 4 spines; propodus, about 22 spinules, 1–3 rows; dactylus slender, about 0.28 propodus length, 6 spines, bifid. Abdomen: ventral margins of pleura of first and second somites mainly straight or slightly concave; third with short faint dorsal transverse sulcus, dorsal posterior margin projected markedly; posterolateral margin of fourth widely recessed at articular knob; fifth with weak posterolateral spine; sixth longer than telson, very slender, with blunt posteroventral projection; telson tapering to rounded tip, 4–7 pairs dorsolateral spines; inner uropod reaching or exceeding telson, outer uropod somewhat longer. Male differs from female in that the outer flagellum of antennule reaches, or nearly reaches, end of antennal scale; inner flagellum correspondingly long (219).

Color Background watery pink, covered by pattern of small red spots along lower, lateral portion of carapace; on pleura of most abdominal somites on distal half of third maxilliped; on spine of antennal scale, eyestalk, basiopodites of pleopods, merus of pereiopod I; red spots more concentrated on posterior of sixth abdominal somite, but scattered on telson and uropods (Plate 7C).

Distinctions In addition to the lack of a ventral spine on pleuron of fourth abdominal somite, and an epipod on any pereiopod, the elegant coastal shrimp has the following distinctive features: relatively long, slender body compressed greatly, resembling a pasiphaeid shrimp in dorsal view; elongate, slender sixth abdominal somite, longer than telson, about 2.2 times longer than fifth somite, but shorter than antennal scale; and keellike ridges on inner margins of eyestalks.

Maximum lengths Males: carapace 5.3 mm, total 33 mm; females: carapace 9.7 mm, total about 60 mm.

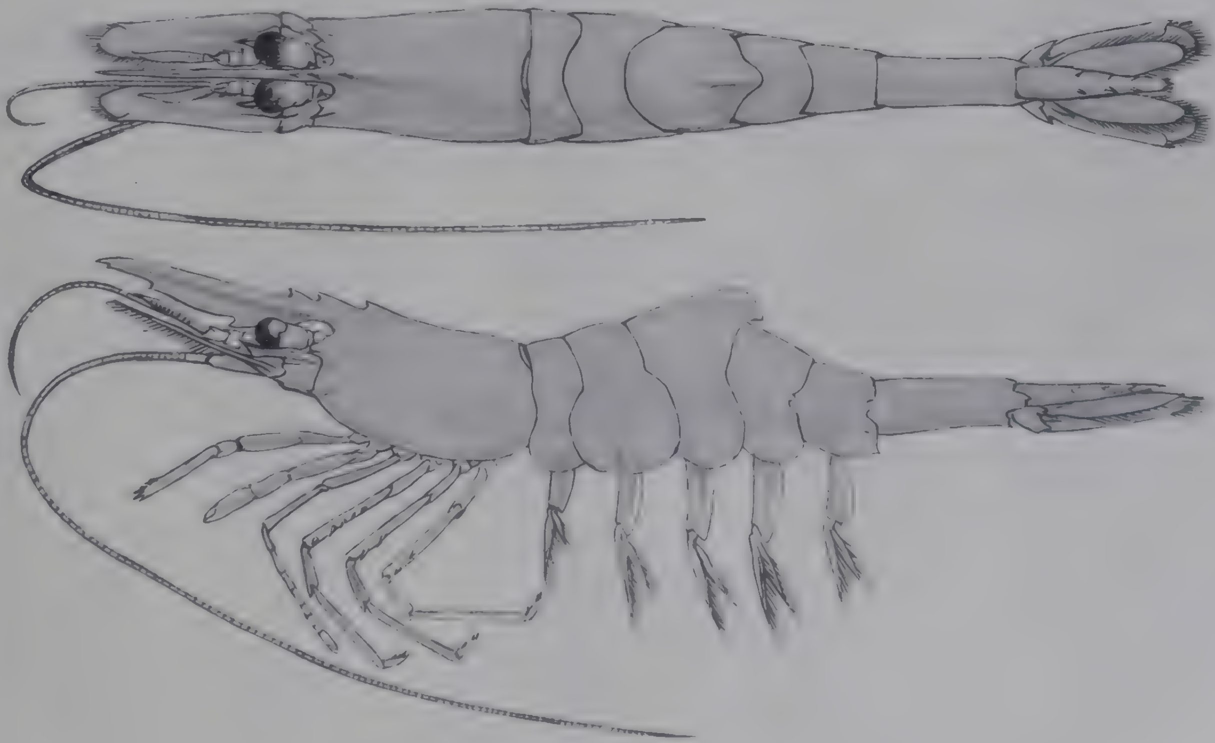
Range Gabriola Island, Strait of Georgia (55) to San Diego CA (219); 22 (290) to 313 m (219).

The species was first recorded in British Columbia waters by the author (55) who collected 2 specimens in a shrimp trawl, north of Gabriola Island at 92 m, Nov. 7, 1961.

Biology and economics The elegant coastal shrimp was found off Gabriola Island, associated with the blunt-bladed shrimp *(Spirontocaris truncata)* and the doll eualid *(Eualus pusiolus),* in the hollow tubular sponge, *Rhabdocalyptus dawsoni. H. decorus* was also caught Aug. 17, 1978, at 44–51 m, near Hudson Rock, about 6 km west of Gabriola Island, in the same type of habitat. A female specimen was taken by trawling off La Pérouse Bank, at 275 m, Feb. 8, 1972. Another ovigerous female, 6.7 mm carapace length, was caught by *G. B. Reed*, southwest of Cape Flattery, at 114 m, Sept. 10, 1968.

THREE-SPINED COASTAL SHRIMP

Heptacarpus tridens (Rathbun, 1902)



Description Body slender, moderately compressed. Shell thin, surface smooth. Rostrum moderately long, about 1.3 carapace length, lower limb wider than upper, ascending, $\frac{2-4}{0-7}$; tip acute. Carapace spines: suborbital strong, rounded; antennal moderate to strong; pterygostomian very weak. Eye moderate, cornea well developed, ridge on inner margin of stalk, tubercle on outer margin. Antennule: peduncle short, third segment shorter than second, distal spines on both segments; stylocerite moderately long; inner flagellum over twice length of outer, latter not reaching end of antennal scale (in female). Antenna: scale about as long as carapace, narrow, lamella exceeding spine considerably; basicerite with upper lateral lobe and lower strong spine; peduncle short; flagellum longer than body. Third maxilliped: moderately long, moderately stout; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; II longer than I, slender; carpus, 7 segments; chelate; III slightly longer, stouter than II; merus, 5 spines; propodus, about 14 spines, 1 row; dactylus moderately stout, about 0.22 propodus length, 4 or 5 spines, bifid; IV slightly longer than III, as stout; merus, 2 or 3 spines; propodus, about 14 spines, 1 row; dactylus moderately stout, about 0.26 propodus length, 4 spines, bifid; V as long as IV, as stout; merus, 2 or 3 spines; propodus, about 12 spines, 1 row; dactylus moderately stout, about 0.24 propodus length, 4 spines, bifid. Abdomen: dorsal posterior half of third somite carinated, and produced posteriorly as conspicuous hump, short, deep, wide groove on each side of carina; posterolateral margins of fourth and fifth markedly recessed at articular knobs; fifth with moderate posterolateral spine; sixth slender, as long as telson, with moderate posteroventral spine; telson narrow, tapering to acute tip; 3 pairs dorsolateral spines; inner uropod shorter than outer, both reach or exceed tip of telson. In male, outer antennular flagellum reaches to end or beyond end of antennal scale.

Remarks Normally 3 dorsal teeth present on rostrum and carapace (217). Also, most local specimens had count of 4 or 5 ventral rostral spines.

Color Body transparent, very fine blue and red spots arranged to give a striped appearance; third maxillipeds red. Antennal flagellum banded with red (109).

Distinctions Distinguished from other coastal shrimps, which also lack ventral spine on pleuron of fourth abdominal somite and epipods on any pereiopods, by fewer dorsal teeth on rostrum and carapace (2–4, normally 3), groove on each side of dorsal carina of third abdominal somite, and antennal scale longer than carapace.

Maximum lengths Males: carapace 6.8 mm, total 42 mm; females: carapace 9.5 mm, total about 61 mm.

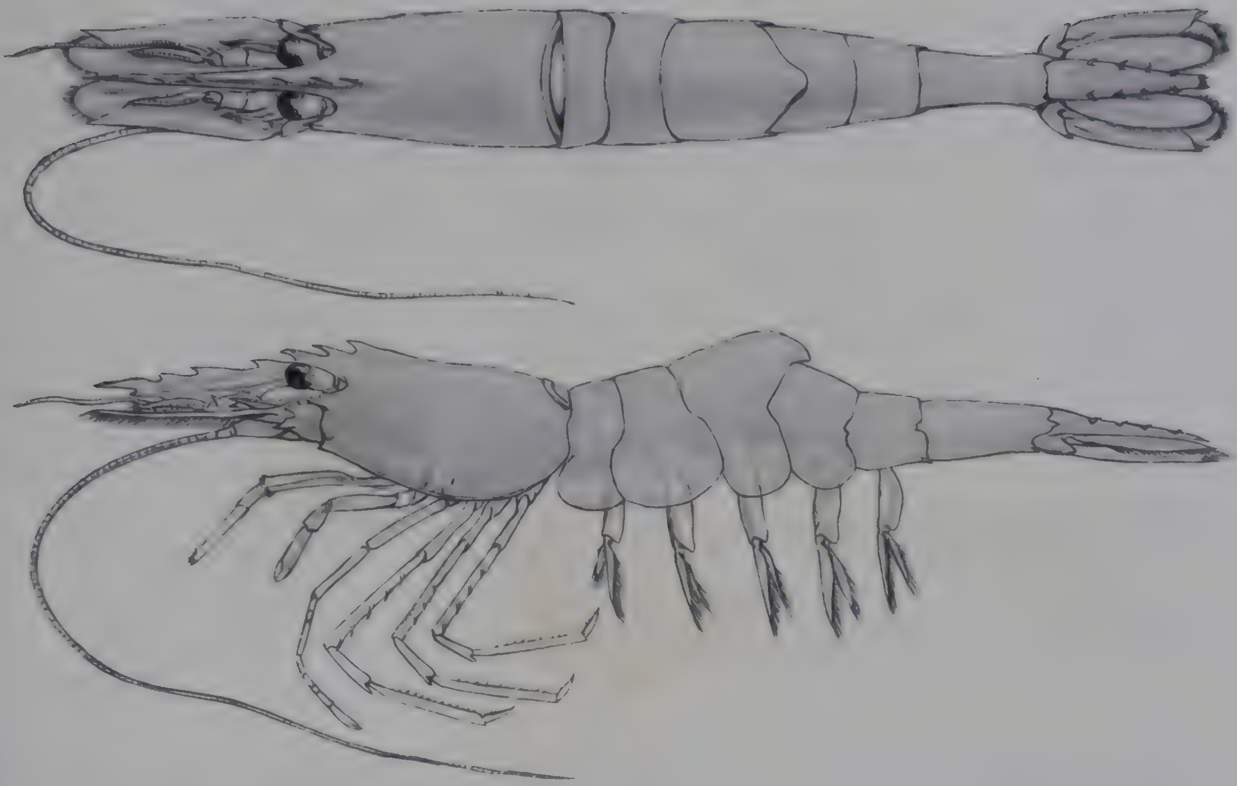
Range Aleutian Islands to Cape Flattery, WA (219), intertidal to 110 m.

First taken in British Columbia waters by the *Albatross* Sept. 4, 1889, east of Victoria at 88 m (station 3465) (219).

Biology and economics This species is common in local waters. Although 1 specimen was caught off Comox at 110 m, practically all material examined was obtained by intertidal and sublittoral sampling to 40 m. Shrimp trawl tows in Naden Harbour, 3–18 m, yielded 77 individuals of *H. tridens*. Three specimens were found in commercial crab traps off Fife Point in Hecate Strait. The species occurred in Parry Bay among kelp *(Laminaria)* in shallow water (109). A parasite is the isopod, *Hemiarthrus abdominalis* (225). An ovigerous female, 7.7 mm carapace length, was collected near Comox, Jan. 25, 1968. The first stage larva is known (197).

NORTHERN COASTAL SHRIMP

Heptacarpus camtschaticus (Stimpson, 1860)



Description Body slender, compressed. Shell thin, surface smooth. Rostrum moderately long, 1.2–1.3 carapace length, upper limb very narrow, horizontal or descending, $\frac{4-7}{4-9}$, tip acute. Carapace spines: suborbital weak, rounded, antennal strong, pterygostomian weak. Eye small, cornea well developed. Antennule: peduncle moderately long, third segment about length of second, each segment with dorsal distal spine; stylocerite moderately long; inner flagellum exceeds antennal scale by about a third of its length, outer half as long or less. Antenna: scale as long as carapace, lamella exceeds spine considerably; basicerite with 2 lateral spines, lower one stronger; peduncle short; flagellum longer than body. Third maxilliped: short, stout; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, slightly stouter; merus, 4 or 5 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus moderately stout about 0.27 propodus length, 6 spines, bifid; IV shorter than III, as stout; merus, 3 or 4 spines; propodus, 14–17 spinules, 1 or 2 rows; dactylus moderately stout, about 0.22 propodus length, 6 spines, bifid; V shorter than IV, as stout; merus, 3 or 4 spines; propodus, about 14 spinules, 1 or 2 rows; dactylus moderately stout, about 0.3 propodus length, 6 or 7 spines, bifid. Abdomen: short transverse sulcus close to dorsal posterior margin of first somite; dorsal posterior margin of third strongly lobed and compressed laterally; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with moderate posterolateral spine; sixth about twice length of fifth, with weak posteroventral spine, and rounded lobe above; telson moderately wide, tapering to rounded tip, 4 or 5 pairs lateral spines; outer uropod longer than inner, both exceed telson. Male, smaller, more slender; rostrum slightly longer, $\frac{5-7}{5-9}$, more ascending; pterygostomian spine weak or obsolescent; outer antennular flagellum longer (219).

Color Unavailable.

Distinctions Separated from other coastal shrimps, which lack a ventral spine on pleuron of fourth abdominal somite, and epipods on any pereiopods, by short third maxilliped, reaching only to middle of antennal scale; antennal scale as long as or longer than the carapace; sixth somite shorter than telson; lamella of antennal scale extending beyond spine; pterygostomian spine.

Maximum lengths Males: carapace 5.1 mm, total 32 mm; females: carapace 8.6 mm, total 45 mm.

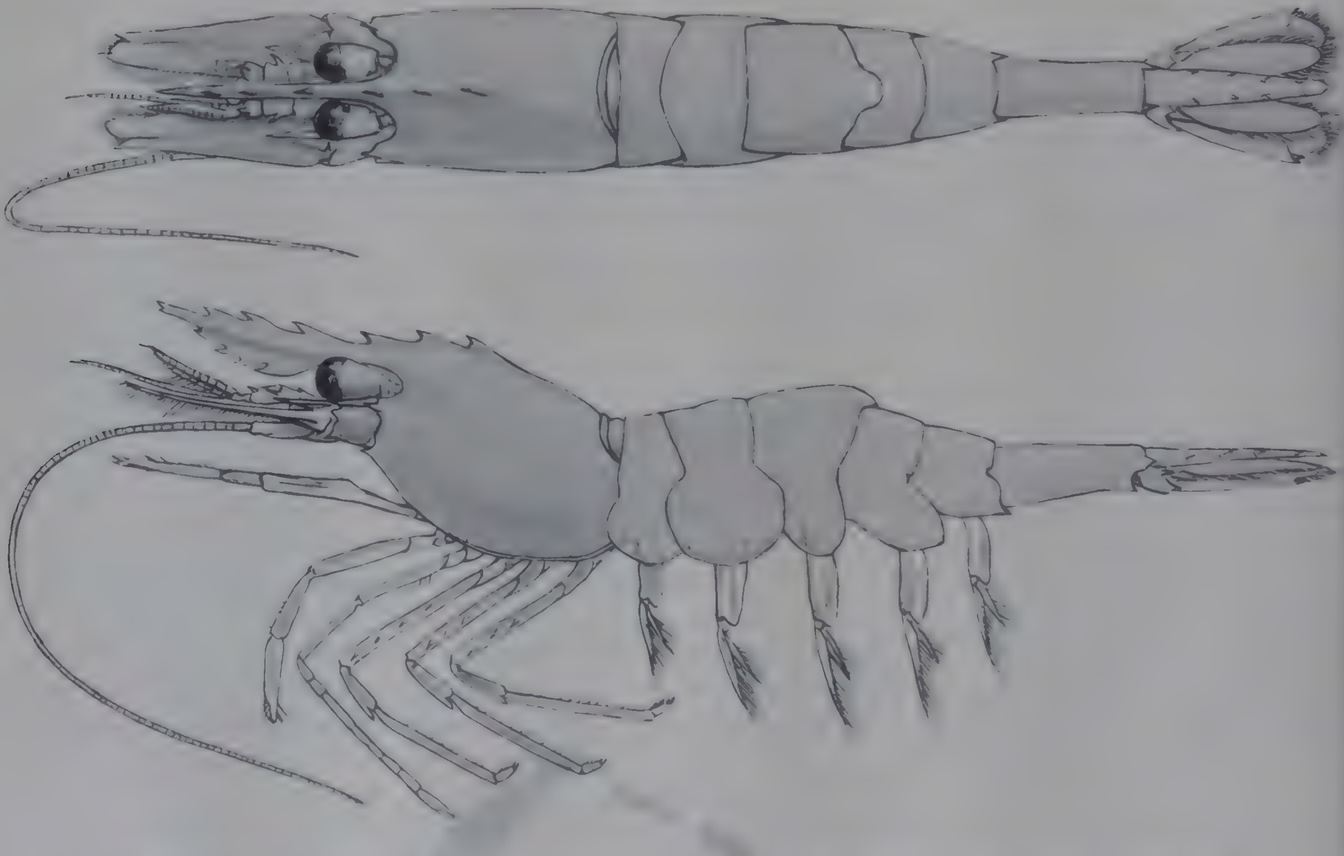
Range Cape Lisburne, Chukchi Sea (219); Bering Sea to Strait of Georgia; Okhotsk Sea; Sea of Japan, to Peter the Great Bay (266); Tokyo Bay (265); intertidal to 108 m (266).

First known record in British Columbia waters, in Newcastle Island Passage, near Nanaimo, at about 6 m, Sept. 20, 1973.

Biology and economics Northern coastal shrimps were collected, including an ovigerous female, 8.0 mm carapace length, in southeastern Alaska and Prince William Sound, mainly in the intertidal zone, at temperatures 6.3–14.3°C, and salinities 17–30.7‰ (250, 43).

KINCAID'S COASTAL SHRIMP

Heptacarpus kincaidi (Rathbun, 1902)



Description Body moderately stout, compressed. Shell thin, surface smooth. Rostrum moderately long 1.2–1.4 carapace length, lower limb wider than upper, concave above eye, slightly ascending, $\frac{5\text{-}6}{5\text{-}6}$, distal ventral tooth in subterminal position, tip acute. Carapace spines: suborbital weak, rounded; antennal moderate to strong; pterygostomian moderate to weak.

Eye large, cornea well developed, ridge on inner surface of stalk. Antennule: peduncle moderately long, third segment subequal to second, latter with lateral spine, dorsal distal spine on third; stylocerite moderately long; outer setiferous flagellum barely exceeding antennal scale, inner exceeding scale by about half its length. Antenna: scale longer than telson, as long as or longer than carapace, spine exceeding lamella slightly; basicerite, upper lateral blunt spine, lower strong spine; peduncle moderately long; flagellum about as long as body. Third maxilliped: long, moderately stout; epipod. Pereiopods: I shorter than third maxilliped, moderately stout; chelate; II longer than I, slender; carpus, 7 segments; chelate; III shorter than II, stouter; merus, 2–4 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus moderately stout, about 0.2 propodus length, 5 or 6 spines, bifid; IV about as long as III, as stout; merus, 2 or 3 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus moderately stout, about 0.15 propodus length, 5 or 6 spines, bifid; V about as long as IV, as stout; merus 2 or 3 spines; propodus, about 20 spinules, 1 or 2 rows; dactylus stout, about 0.16 propodus length, 5 or 6 spines, bifid. Abdomen: dorsal posterior margin of third somite produced as flattened, caplike lobe; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with strong posterolateral spine; sixth with weak posteroventral spine; telson narrow, tapering to acute tip, 4 pairs dorsolateral spines; inner uropod shorter than outer, latter barely reaches tip of telson.

Remarks The late Trevor Kincaid was Professor of Zoology at the University of Washington, Seattle, 1901–47, and Director of the Friday Harbor Laboratory, 1910–15.

Color Body mainly transparent; closely spaced red dots over most of carapace, also buff to yellow spots on branchial region; inner margin of eyestalk reddish; lower limb of rostrum red, midrib milkish; antenna, peduncle with speckling and streaks of red, flagellum with dark red bands, outer margin of scale red; third maxillipeds, held against ventral surface of antennal scale, appear almost entirely red; pereiopods banded dark red, some buff specks; red dots sparser on abdomen than on carapace; gut appears milkish and partly red through shell, red spots and short transverse bars on dorsal midline from about second somite to sixth somite, buff blotches and bars on lateral surfaces of somite, telson has lateral margins reddish, longitudinal buff bars on uropods; viscera seen clearly through shell. Eggs carried by females, pale green. Description taken from 2 Kodachrome transparencies, kindly provided by N. McDaniel.

Distinctions *H. kincaidi* belongs to a group of 5 local coastal shrimps, characterized by absence of ventral spine on fourth somite. Distinguished from others by antennal scale as long as or longer than carapace; spine of antennal scale exceeding lamella; third maxilliped, when extended, reaching or exceeding tip of antennal scale; dorsal posterior margin of third somite produced as flattened, caplike lobe.

Maximum lengths Males: lengths unavailable; females: carapace 6.0 mm, total 35 mm.

Range Discovery Passage, east coast of Vancouver Island to San Pedro, CA (232); 10–183 m (232). Northern limit and shallow limit supplied by N. McDaniel.

Apparently the first record of the species in British Columbia waters was Taylor (258), who reported collecting it in Burrard Inlet sometime before 1912.

Biology and economics Until recently one had the impression that this shrimp was quite rare. There are published references (219, 232) to perhaps 6 specimens, if one assumes that Taylor (258) and Kincaid (219) each caught a single specimen, and the author had 3 specimens caught locally by trawling. Now, as will be seen from the following unpublished underwater observations kindly supplied by N. McDaniel, it is evident that *H. kincaidi* is a common species.

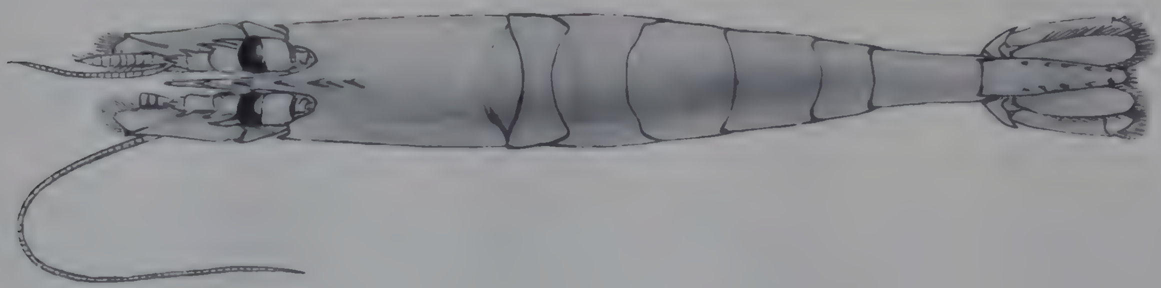
> "Although less conspicuous than *Lebbeus grandimanus* because of its subtle colouration, *Heptacarpus kincaidi* is actually more commonly found with the anemone *Cribrinopsis fernaldi* than is *Lebbeus* in the Strait of Georgia. Probably because of their smaller size, *Heptacarpus*

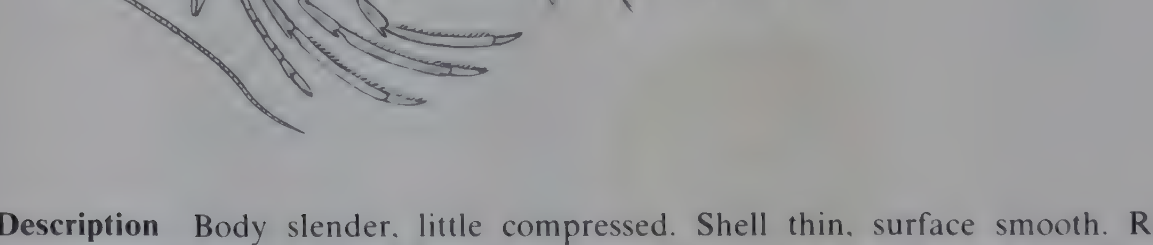
> is sometimes found in large numbers, up to 10–15 per anemone. They behave similarly to *Lebbeus*, standing at the base of the anemone, or clinging to the column in a head-down vertical position. About 80% of *Cribrinopsis* observed in the Strait of Georgia have associated *H. kincaidi*. *Heptacarpus* seems less inclined to venture onto the tentacular crown of the anemone, and tend to jump away from the anemone when greatly disturbed, apparently relying on their cryptic colouration for protection. *H. kincaidi* has also been observed with another anemone, *Tealia crassicornis*, but not so far, with *Tealia piscivora*.
>
> "Both *Lebbeus* and *Heptacarpus*, may be found on the same anemone; there appears to be no interspecific aggression between the two shrimps. Ovigerous females are commonly observed during January."

An ovigerous female, 4.9 mm carapace length, was collected near Nanaimo, Dec. 31, 1971.

LARGE-EYED COASTAL SHRIMP

Heptacarpus littoralis n.sp.





Description Body slender, little compressed. Shell thin, surface smooth. Rostrum moderately long, variable, 0.75–1.3 carapace length, extending to or beyond second segment of antennular peduncle, mainly horizontal, $\frac{5-7}{1-3}$, tip acute. Carapace spines: suborbital weak, rounded; antennal moderate to strong; pterygostomian absent. Eye very large, stalk stout, ocellus conspicuous, tip of cornea reaching distal half of rostrum (Fig. 17A). Antennule: peduncle extends beyond middle of antennal scale, third segment about half length of second, lateral distal spines on first and second segments, dorsal distal spine on third; stylocerite not reaching end of first segment; inner longer than outer, latter setiferous. Antenna: scale shorter than telson, lamella longer medially, exceeds spine; basicerite, small upper lateral lobe, lower weak spine; peduncle extending to about middle of antennular

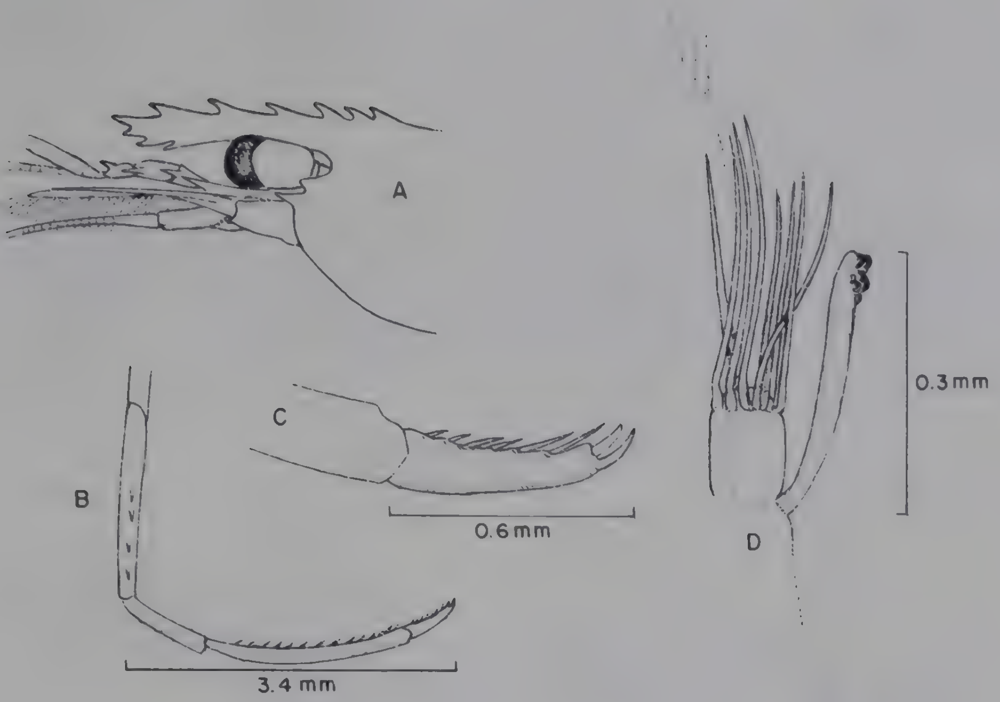


FIG. 17. *Heptacarpus littoralis* n.sp. (A) anterior lateral view, (B) pereiopod III (left), (C) dactylus of pereiopod III (left), (D) appendix masculina.

peduncle; flagellum as long as body. Third maxilliped: extended, reaches tip of antennal scale, moderately stout; antepenultimate segment with lateral ridge; distal segment setiferous; epipod. Pereiopods: I about as long as third maxilliped, stouter; dactylus and fixed finger of chela about 0.45 palm length; epipod; II about 1.25 length of I, slender; carpus, 7 segments; dactylus and fixed finger of chela about 0.6 palm length; III about 1.3 length of II, extended, overreaches tip of antennal scale by about half of propodus; slender; merus, 2 or 4 spines; propodus, 0.9–1.1 meral length, curved, about 33 spinules, 2 rows; dactylus slender, about 0.32 propodus length, 7 or 8 spines, bifid (Fig. 17B, C); IV about as long as III, as slender; merus, 3 spines; propodus about 1.1 meral length, curved, about 35 spinules, 2 rows; dactylus slender, about 0.3 propodus length, 9 spines, bifid. V almost as long as IV, extended, barely reaches tip of antennal scale; slender; merus, 1 or 3 spines; propodus about 1.1 meral length, curved, about 36 spinules, 2 rows; dactylus slender, about 0.3 propodus length, 5–8 spines, bifid. Abdomen: faint transverse suture on second somite; fourth and fifth recessed at articular knobs; former with weak to moderate ventral spine, latter with moderate to strong posterolateral spine; sixth shorter than telson, posteroventral spine weak; telson narrow, tapering to blunt tip, 6 spines, 5 or 6 pairs dorsolateral spines; outer uropod reaching end of telson, outer margin ending in fixed spine with adjacent movable spine, inner uropod as long as outer, both exceeding tip of telson. Mandible as for the genus. Appendix masculina of male short, less than half length of appendix interna, stout, tip rounded, with 8 long spinules (Fig. 17D).

Remarks Within the genus *Heptacarpus*, this new species fits with *H. sitchensis* and *H. moseri* into a group that has in common an epipod on the first pereiopod, and ventral margin of pleuron of fourth abdominal somite with a spine. *H. littoralis* differs from others by lacking a pterygostomian spine; propodi of pereiopods III–IV curved, that is, concave on the flexor margins. It resembles *H. sitchensis* most closely, particularly in shape and armature of the rostrum, but differs from the latter by its more slender body, larger eyes, and narrower antennal scale, with lamella longer medially. The specific name, *littoralis*, makes reference to the habitat of the species.

Material examined Most specimens were collected by D. B. Quayle in 1972, and by the author and associates in 1973; the rest were taken by E. L. Bousfield on Vancouver Island in 1955, and in southeastern Alaska in 1961. Alaskan specimens were described in part as *Heptacarpus* sp. (250). Measurements are carapace lengths. Piper's Lagoon, intertidal, July 8, 1955, 5♀ 1.2–1.9 mm; 2 immature 1.1 and 1.3 mm. Parksville, intertidal, July 28, 1955, 2 immature 1.0 and 1.3 mm. Kakul Narrows, Baranof Island, AK (57°22N, 135°41W), intertidal, June 9, 1961, 6♂ 1.9–2.4 mm (NMC 15044). Hanus Bay, Baranof Island, AK (57°24N, 135°1W), intertidal, June 10, 1961, 2♀ 2.5 and 2.6 mm (NMC 15042). Prescott Passage, 2–7 m, May 13, 1972, 1♂ 4.6 mm, 1♀ 2.3 mm. Refuge Cove, 2–7 m, May 13, 1972, 2♂ 2.2 and 2.5 mm, 1♀ 2.0 mm. Burnaby Narrows, 2–7 m, May 15, 1972, 5♂ 2.2–2.7 mm, 5♀ 2.0–2.3 mm. Bunsby Islands, 2–9 m, July 16, 1972, 7♂ 2.2–2.9 mm, 1♀ 2.8 mm. Type locality. Duke Point, intertidal, June 27, 1973, 10♂ 2.3–3.7 mm, 3♀ 2.3–2.8 mm. Departure Bay, 15 m, Nov. 14, 1973, 1♀ 3.2 mm.

Six specimens collected by E. L. Bousfield at Cottam Point, east coast of Vancouver Island, July 30, 1955, were not examined.

Types: The holotype is a male, 2.9 mm carapace length, and 17 mm total length; it is deposited in the National Museum of Canada (NMC 21601), with a paratype, a male, 2.5 mm carapace length, and 15 mm total length (NMC 21602). Other specimens are in the British Columbia Provincial Museum, Victoria, B.C., and the National Museum of Natural History, Washington, D.C.

Color Unavailable.

Distinctions *H. littoralis* is separated from other coastal shrimps with ventral spine on pleuron of fourth abdominal somite, and an epipod on pereiopod I, by absence of pterygostomian spine, and curved propodi of pereiopods III–V. Distinguished from *H. sitchensis,* morphologically similar and occurring in same habitat, by more slender body, larger eyes, and antennal scale, narrower with lamella longer medially.

Maximum lengths Males: carapace 3.7 mm, total 20 mm; females: carapace 3.2 mm, total 19 mm.

Range Baranof Island, AK to Duke Point, south Strait of Georgia; intertidal to 15 m.

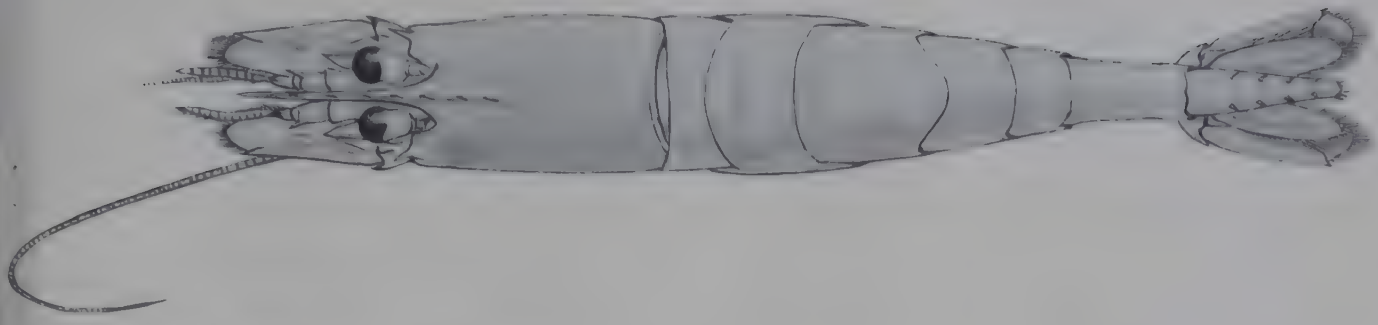
First collected on the British Columbia coast by E. L. Bousfield at Piper's Lagoon, July 8, 1955.

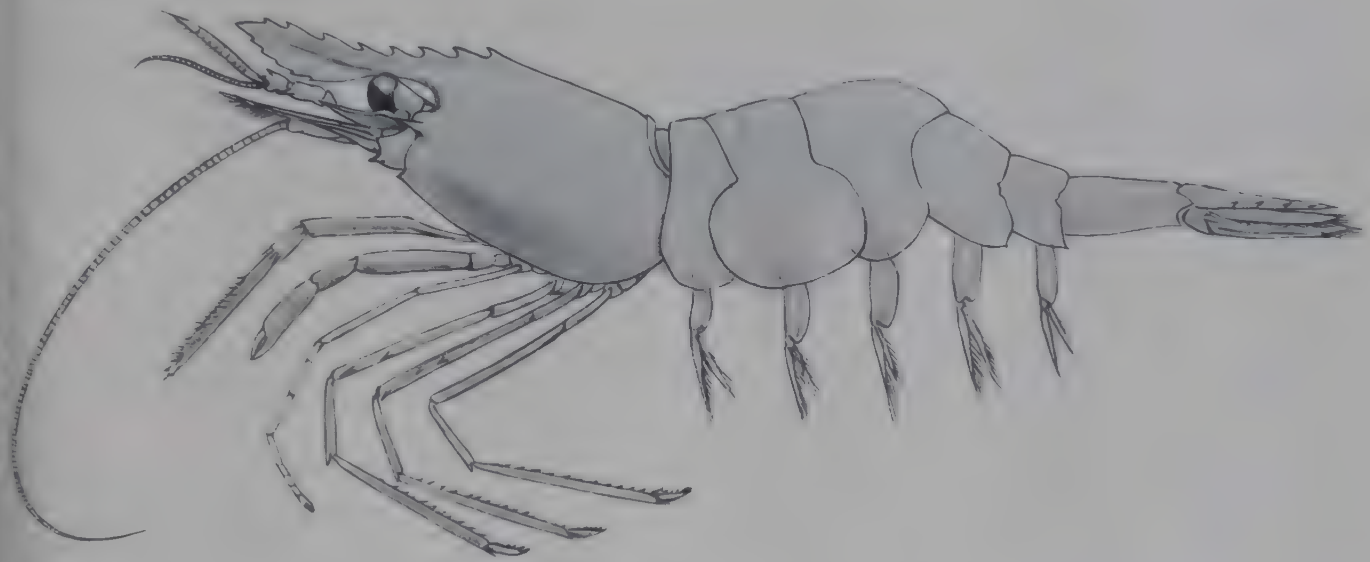
Biology and economics *H. littoralis* was collected on the British Columbia coast intertidally and in the sublittoral to 9 m, among eelgrass and brown algae. Associated species were *H. sitchensis, H. brevirostris, H. tenuissimus, Hippolyte clarki, Spirontocaris ochotensis,* and immature *Pandalus danae,* and *P. hypsinotus. H. littoralis* apparently is less common than *H. sitchensis.*

This shrimp occurred in southeastern Alaska intertidally at 8.0°C and salinities 29.0–29.9‰ (250, 43).

ALASKA COASTAL SHRIMP

Heptacarpus moseri (Rathbun, 1902)





Description Body moderately stout, compressed. Shell thick, surface smooth. Rostrum moderately long, 0.8–1.0 carapace length, slightly ascending, lower limb normally wider than upper, $\frac{5-8}{1-7}$, tip acute. Carapace spines: suborbital moderate, rounded; antennal strong; pterygostomian moderate or weak. Eye moderate, cornea well developed, ridge on inner margin of stalk. Antennule: peduncle moderately long, third segment shorter than second, each with dorsal distal spine; stylocerite short, knifelike; inner flagellum longer than outer, both exceed antennal scale considerably. Antenna: scale about as long as telson, lamella tapering, exceeds spine; basicerite with 2 lateral spines; peduncle long; flagellum shorter than body. Third maxilliped: long, stout; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, slightly stouter; merus, 0–3 spines; propodus, 26–30 spinules, 1 or 2 rows; dactylus moderately stout, about 0.24 propodus length, 6 or 7 spines, bifid; IV shorter than III, as stout; merus, 3 spines; propodus, 23–26 spinules, 1 or 2 rows; dactylus moderately stout, about 0.23 propodus length, 6 or 7 spines, bifid; V shorter than IV, as stout; merus, 0–3 spines; propodus, 18–26 spinules in 1 or 2 rows, tuft of setae at distal extensor margin; dactylus moderately stout, about 0.2 propodus length, 7 spines, bifid. Abdomen: second somite with transverse sulcus; pleuron of fourth with weak ventral spine; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with strong posterolateral spine; sixth shorter than telson, slender, with weak posteroventral spine; telson moderately wide, tapers abruptly to blunt tip, with 4 or 5 pairs lateral spines; outer uropod longer than inner, both extend beyond telson.

Remarks Reported variations from the original description (217), such as counts of rostral and telson spines and length of sixth somite noted on immature specimens in shallow water, have been observed in recent years on adults from deep water.

Color Translucent background; broad bands of deep cardinal spots on carapace and first to fifth abdominal somites; sixth abdominal somite, uropods, and telson with patches of red-orange; small patches of deep cardinal red on antennal region of carapace, rostrum colorless; third maxilliped and pereiopod almost entirely red-orange; same color on lower half of eyestalk, stylocerite, and flagellum of antennule, scale, peduncle, and flagellum of antenna, and basiopodites of pleopods; endopods and exopods of pleopods light cardinal red (Plate 6A). Coloration of specimens caught among algae growing on the edge of a float was reported as very transparent (109), diagonally striped with blue on carapace, pereiopods, and pleopods; some had fine red dots on the blue stripes.

Distinctions *H. moseri* is placed, with *H. sitchensis* and *H. littoralis,* in a group of coastal shrimps with a ventral spine on pleuron of fourth abdominal somite, and an epipod on third maxilliped and pereiopod I. It is distinguished by ridge on inner surface of eyestalk; third maxilliped and pereiopods II–V that, when extended forward, overreach end of antennal scale considerably; rostrum with broad lower limb, armed normally with more ventral spines, more evenly spaced and smaller than on the other 2 species.

Maximum lengths Males: carapace 6.2 mm, total unavailable; females: carapace 9.1 mm, total about 43 mm.

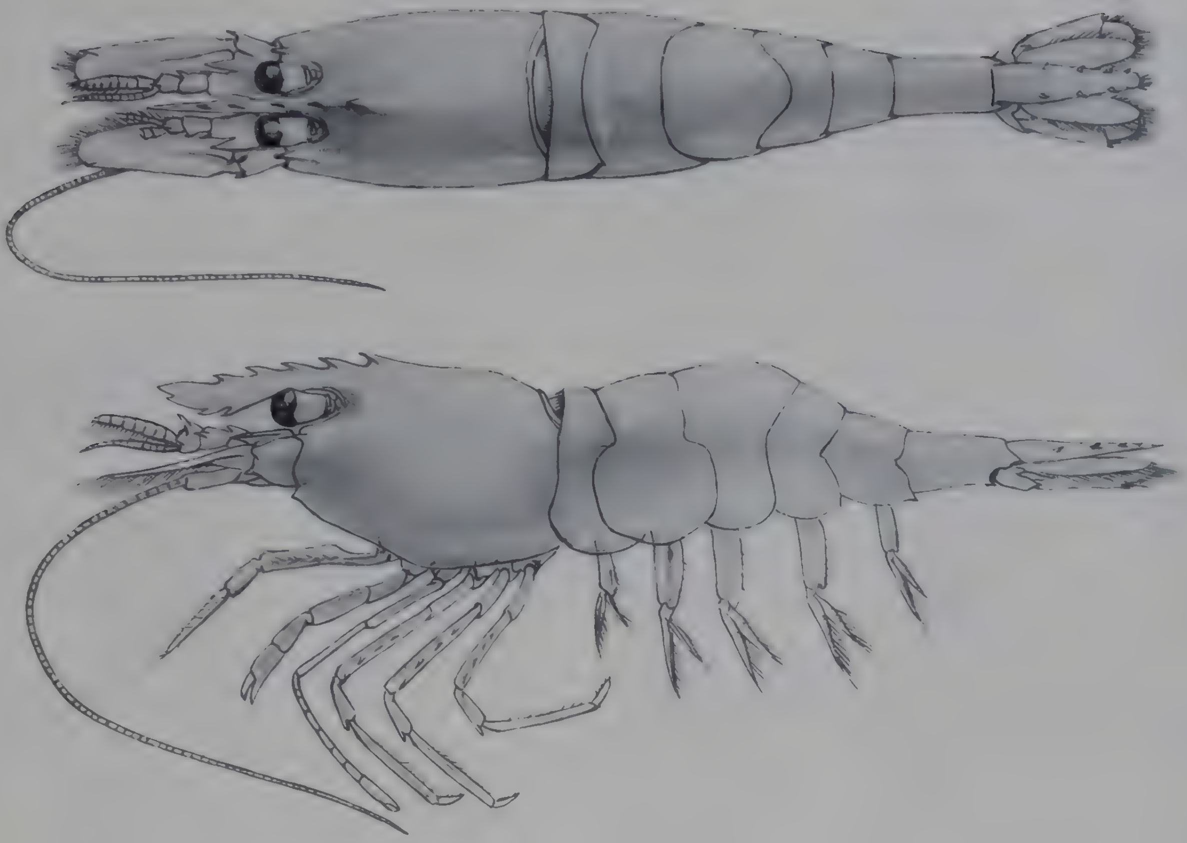
Range Pribilof Islands, Bering Sea to Destruction Island, WA (219); intertidal (109) to 1100 m. This maximum depth was at a station off La Perouse Bank (48° 16.6′N, 126° 14.0′W), where *G. B. Reed* caught 13 specimens Sept. 17, 1968.

The species was first collected on the British Columbia coast by the *Albatross* Aug. 31, 1888, northwest of Cape Scott at 374 m (station 2861) (219).

Biology and economics Prior to the summer of 1928, when Hart (109) found specimens among algae on a float in Brentwood Bay, *H. moseri* had not been recorded shallower than 110 m. Ovigerous females, 3.6–5.1 mm carapace length, were collected intertidally around Effingham Island in Barkley Sound, May 31, 1950.

COMMON COASTAL SHRIMP

Heptacarpus sitchensis (Brandt, 1851)



Description Body stout, little compressed. Shell thin, surface smooth. Rostrum moderately long, 0.9–1.1 carapace length, knifelike, descending, $\frac{4\text{-}7}{1\text{-}4}$, tip acute. Carapace spines: suborbital moderate, rounded; antennal moderate; pterygostomian weak to moderate. Eye large, cornea well developed. Antennule: peduncle moderately long, third segment subequal to second, dorsal distal spine on each of 3 segments; stylocerite moderately long; inner flagellum slightly longer than outer, latter setiferous, both barely exceed antennal scale. Antenna: scale longer than telson, lamella exceeding spine slightly; basicerite, upper lateral lobe or blunt spine, lower moderate spine; peduncle moderately long; flagellum shorter than body. Third maxilliped: short, not reaching end of antennal scale, moderately stout; antepenultimate segment with lateral ridge; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; III slightly longer than II, stouter; merus, 4 spines; propodus about 26 spinules, 1 or 2 rows; dactylus moderately stout, about 0.26 propodus length, 6 spines, bifid; IV longer than III, as stout; merus, 4–6 spines; propodus 27–34 spinules, 1 or 2 rows; dactylus moderately stout, about 0.3 propodus length, 6 or 7 spines, bifid; V shorter than IV, as stout; merus, 2–4 spines; propodus 20–22 spinules, 1 or 2 rows; dactylus moderately stout, about 0.26 propodus length, 6 or 7 spines, bifid. Abdomen: dorsal posterior margin of third somite projected moderately; posterolateral margins of fourth and fifth widely recessed at articular knobs; pleuron of fourth with moderate ventral spine; fifth with moderate posterolateral spine; sixth shorter than telson, with moderate posteroventral spine; telson moderately wide, tapering to acute tip, 4 pairs dorsolateral spines; inner and outer uropods about equal length, both reach or exceed telson slightly.

Color Carapace and abdomen faintly striped with bands of fine red and blue spots, on semitransparent brown. Pereiopods, pleopods, and telson, blue striped (109).

Distinctions Separated from other coastal shrimps with a ventral spine on pleuron of fourth abdominal somite, and with an epipod on only first pereiopod, by antennal scale longer than telson; outer or thicker antennular flagellum, barely exceeding end of antennal scale; meral spines on pereiopods III–V, located over most of length of segments.

Maximum lengths Males: carapace 3.2 mm, total about 16 mm; females: carapace 5.7 mm, total 28 mm.

Range Resurrection Bay, AK (250, 43) to Yaquina Bay, OR; intertidal to 12 m. Specimens from Yaquina Bay provided by E. E. Krygier.

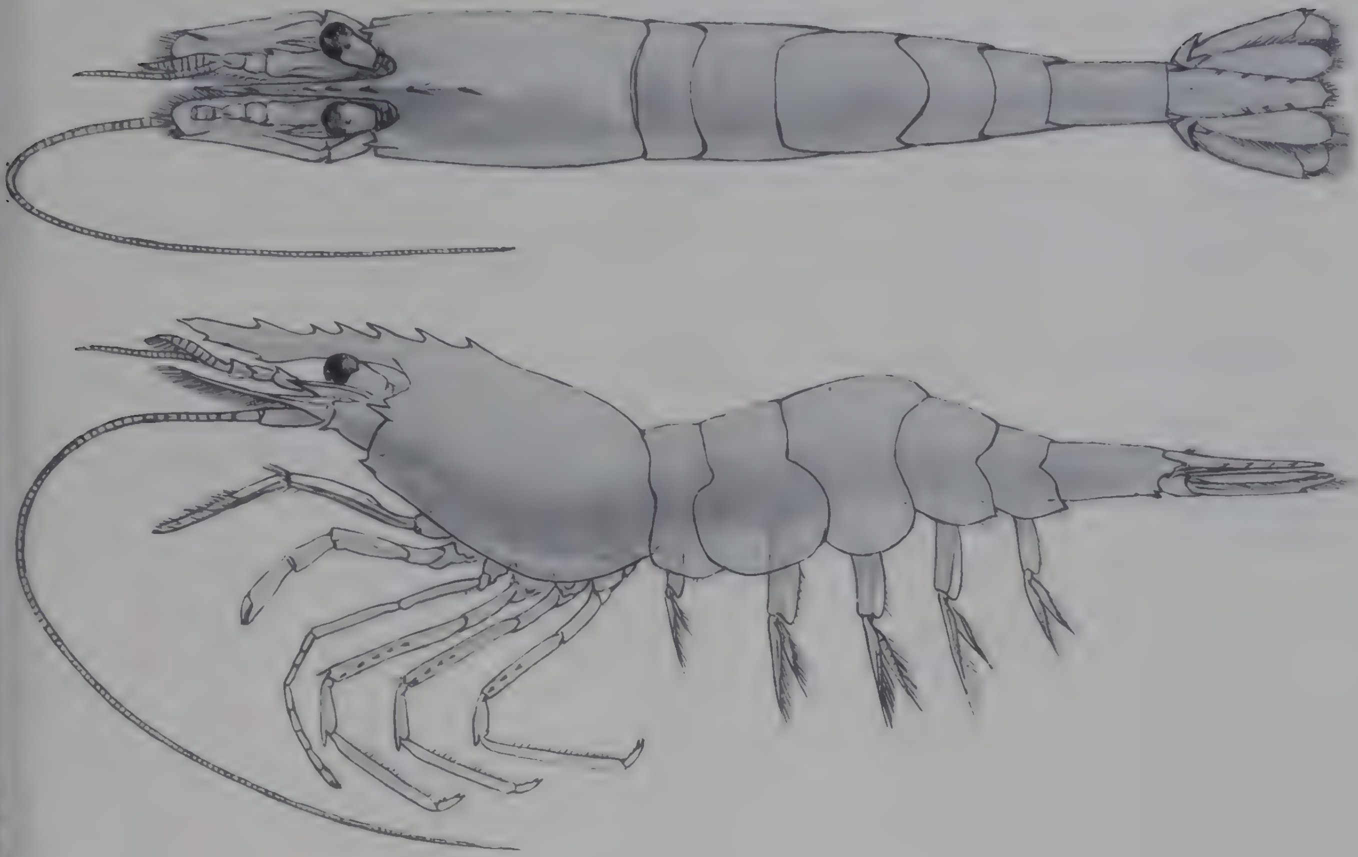
Apparently the species was recorded for the first time on the British Columbia coast by Hart (109), who collected it intertidally in Ross Bay, near Victoria, in 1928.

Biology and economics Examination of collections made by D. B. Quayle (Burnaby Narrows, Hudson Bay Passage, Bunsby Islands), by E. L. Bousfield (Vancouver Island) (42), and by the author (Nanaimo area), has revealed that *H. sitchensis* is common and widespread along the west coast of Canada. Summer collecting on mud flats, coarse sand, and sandy, gravel beaches, and a steep rocky shore, in southern British Columbia (42), yielded *H. sitchensis;* temperatures were 10.3–17.1°C and salinities 17.5–29.9‰. Specimens occurred in similar habitats on Alaska beaches, at temperatures and salinities of 8.0–14°C and 5.3–30.9‰, respectively; types of vegetation mentioned in field notes were eelgrass, kelp, and *Laminaria* (250, 43).

Ovigerous females, 3.7–5.6 mm carapace length, were caught in the Nanaimo River estuary and Burnaby Narrows in May, June, and September. *H. sitchensis* is infested by an abdominal isopod, identified by the author as *Hemiarthrus abdominalis.*

CALIFORNIA COASTAL SHRIMP

Heptacarpus paludicola Holmes, 1900



Description Body moderately stout, little compressed. Shell thin, surface smooth. Rostrum moderately long, 0.9–1.0 carapace length, knifelike, slightly descending, $\frac{6-8}{2-4}$, tip acute. Carapace spines: suborbital moderate, blunt tip; antennal strong; pterygostomian moderate. Eye moderate, cornea well developed. Antennule: peduncle long, third segment subequal to second, dorsal distal spine on each of 3 segments; stylocerite moderately long; inner flagellum longer than outer, both extending beyond antennal scale, outer setiferous. Antenna: scale about as long as telson, lamella exceeding spine slightly; basicerite, upper lateral pointed lobe, lower strong spine; peduncle moderately long; flagellum shorter than body. Third maxilliped: moderately long, moderately stout; antepenultimate segment with outer lateral ridge, distal spine; distal segment setiferous; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; epipod; II longer than I, slender; carpus, 7 segments; chelate; epipod; III shorter than II, stouter; merus, 5 spines; propodus about 20 spinules, 1 or 2 rows; dactylus moderately stout, about 0.22 propodus length, 5 spines, bifid; IV shorter than III, as stout; merus, 4 spines; propodus, about 18 spinules, 1 or 2 rows; dactylus moderately stout, about 0.23 propodus length, 6 spines, bifid; V slightly shorter than IV, as stout; merus, 2–4 spines; propodus, about 20 spinules, 1 or 2 rows; dactylus moderately stout, about 0.25 propodus length, 5 or 6 spines, bifid. Abdomen: dorsal posterior margin of third somite projected moderately; posterolateral margins of fourth and fifth recessed at articular knobs; pleuron of fourth with weak ventral spine; fifth with strong posterolateral spine; sixth with moderate posteroventral spine, and weak spine above; telson moderately wide, tapering to acute tip, 4 or 5 pairs dorsolateral spines; uropods about equal, both as long as or slightly shorter than telson.

Color Specimens taken in Brentwood Bay, among algae on the edge of a float, were transparent, carapace diagonally striped with fine red spots; legs banded with pale blue (109). In California, Holmes (128) described the species as uniform green; more recently, color was noted as uniform green, with broken red-brown stripes on carapace (68).

Distinctions Distinguished from other coastal shrimps, with a ventral spine on pleuron of fourth abdominal somite, by epipods on pereiopods I and II; antennal scale about as long as telson; pterygostomian spine present; rostrum almost reaching tip of antennal scale.

Maximum lengths Males: carapace 3.6 mm, total about 20 mm; females: carapace 6.4 mm, total 32 mm.

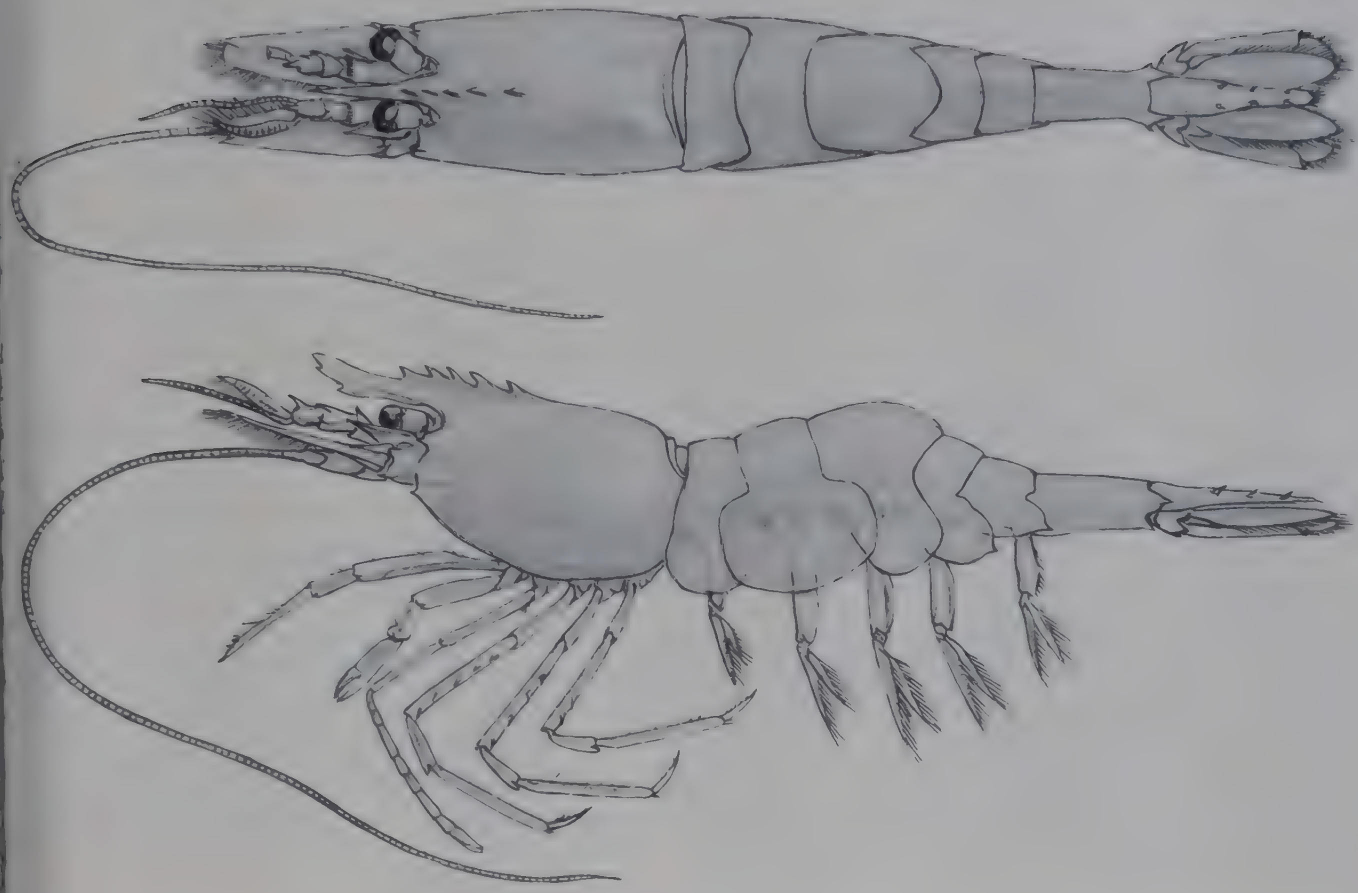
Range Tava Island, AK (250, 43), to San Diego, CA (219); intertidal to 10 m (219).

The first known record of *H. paludicola* along the British Columbia coast was by Smith (238), who collected specimens in 1926 or 1927 near the Saanich Peninsula, in shallow water.

Biology and economics This species does not appear to be as common in the intertidal zone as *H. sitchensis*. Ovigerous females, 3.8–5.2 mm carapace length, were collected in Burnaby Narrows and in Skidegate Channel in May, June, and July. A parasitic isopod was found on the anterior part of the ventral side of the abdomen of a specimen caught near Sitka, AK (250), likely *Hemiarthrus abdominalis*. The first larval stage has been described (197).

STIMPSON'S COASTAL SHRIMP

Heptacarpus stimpsoni Holthuis, 1947



Description Body moderately stout, little compressed. Shell thin, surface smooth. Rostrum short, about 0.7 carapace length, knifelike, ascending, $\frac{5-8}{1-4}$, tip acute. Carapace spines: suborbital moderate, rounded; antennal moderate; pterygostomian weak to moderate. Eye moderate, cornea well developed, ridge on inner surface of stalk. Antennule: peduncle long, third segment longer than second, dorsal distal spine on both segments, dorsal distal spinules on first segment; stylocerite moderately long; inner flagellum almost double length of outer, latter barely exceeds antennal scale. Antenna: scale about as long as telson, spine exceeding lamella slightly; basicerite with upper lateral pointed lobe, lower moderate spine; peduncle moderately long; flagellum as long as body. Third maxilliped: long, moderately stout; outer lateral ridge on antepenultimate segment; epipod. Pereiopods: I shorter than third maxilliped, stout; chelate; palm longer than dactylus and fixed finger in female; epipod; II longer than I, slender; carpus, 7 segments; chelate; III longer than II, stouter; merus, 4 or 5 spines; propodus, about 24 spinules, 1 or 2 rows; dactylus slender, about 0.4 propodus length, 4 or 5 spines; IV slightly shorter than III, as stout; merus, 4 spines; propodus about 22 spinules, 1 or 2 rows; dactylus slender, about 0.35 propodus length, 5 spines; V shorter than IV, as stout; merus 2–4 spines, propodus about 20 spinules, 1 or 2 rows; dactylus slender, about 0.35 propodus length, 5 spines. Abdomen: dorsal posterior margin of third somite projected moderately; pleuron of fourth with weak to moderate ventral spine; posterolateral margins of fourth and fifth widely recessed at articular knobs; strong posterolateral spine on fifth; sixth shorter than telson, with moderate posteroventral spine, strongly flared; telson narrow, tapering abruptly to acute tip, 3 pairs dorsolateral spines: inner and outer uropods about same length, both reaching or exceeding telson. Male, body more slender; rostrum shorter and more slender; chela of pereiopod I with dactylus and fixed finger longer than palm (219).

Remarks Ten females caught in Prince William Sound (station A86) (43) and identified as *H. pictus* (250) are in fact *H. stimpsoni* (National Museum of Canada, Ottawa, NMC 20902). The original identification of 4 males, collected in Constantine Harbor (station A79, rather than A86), as *H. stimpsoni* (250) was confirmed by the present author (NMC 20879).

William Stimpson was an American carcinologist who published important papers on decapod crustaceans of the North Pacific Ocean, including shrimps, around 1860.

Color Unavailable.

Distinctions Separated from other coastal shrimps with a ventral spine on pleuron of fourth abdominal somite by epipods on pereiopods I–III; slender dactyli of pereiopods III–V, 0.35–0.4 lengths of their propodi, without bifid tips; rostrum normally with ventral spines.

Maximum lengths Males: carapace 5.0 mm, total 23 mm; females: carapace 6.9 mm, total 32 mm.

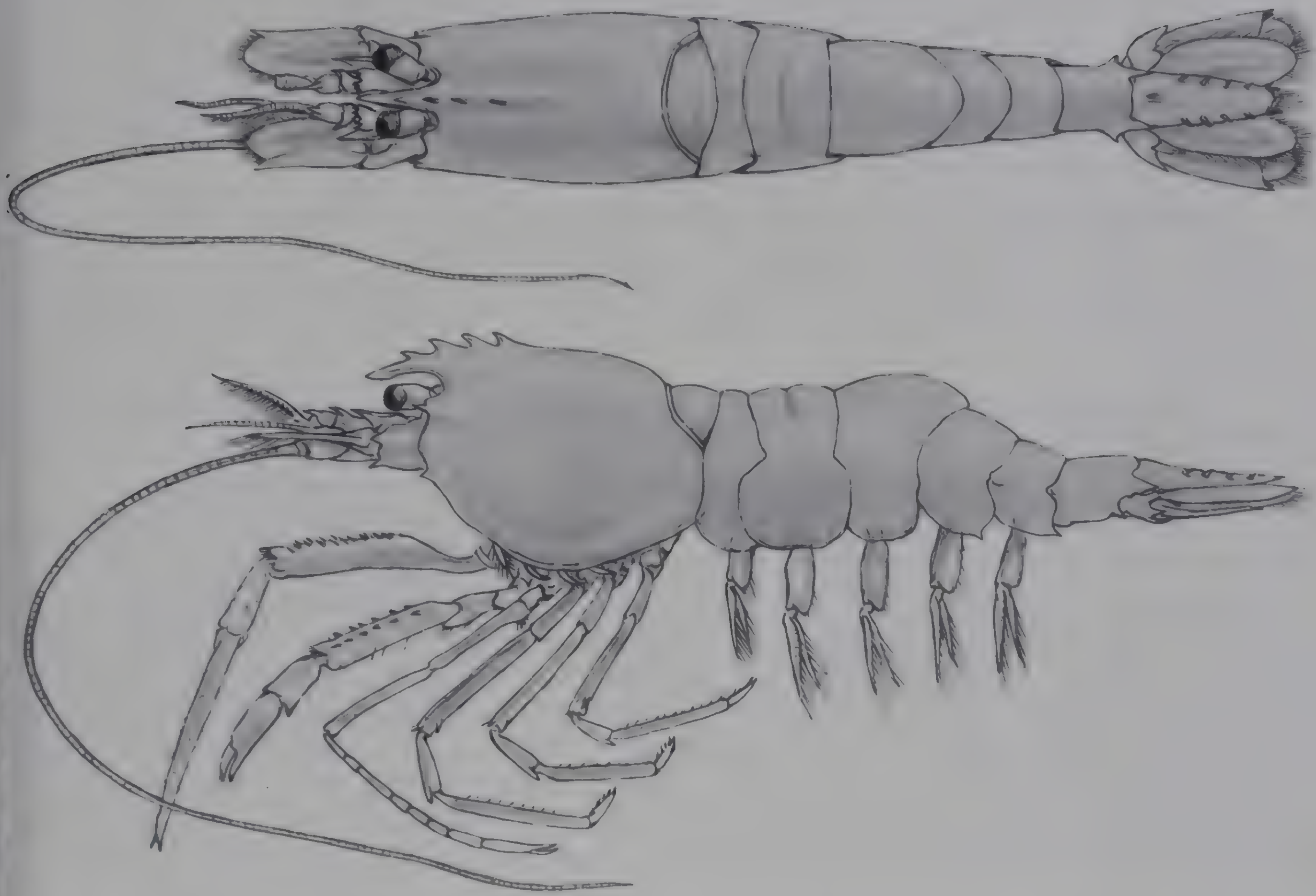
Range Sheep Bay, AK (250, 43), to San Diego, CA (219); intertidal to 73 m.

The earliest known capture of *H. stimpsoni* in British Columbia waters was by the *William J. Stewart*, June 19, 1934, off Nootka Sound, at 73 m (station 2231–19).

Biology and economics Stimpson's coastal shrimp does not appear to be a common species. Ovigerous females, 5.1–6.9 mm carapace length, were found at several localities in May, June, July, and August. In McIntyre Bay, July 31, 1962, ovigerous females were taken off a crab trap buoy line; and Aug. 5 of the same year, a male was caught in a crab trap set off Fife Point. Distribution of *H. stimpsoni* in California is stated to be generally sublittoral, occasionally in the low intertidal of rocky coasts, among eelgrass, or among algae on pilings (68).

STOUT COASTAL SHRIMP

Heptacarpus brevirostris (Dana, 1852)



Description Body stout, robust, little compressed, carapace deep. Shell thick, surface smooth. Rostrum short, 0.3–0.4 carapace length, descending, $\frac{2-6}{0}$, tip acute, rarely bifid. Carapace spines: suborbital moderate, rounded; antennal strong; pterygostomian moderate. Eye small, stalk slender, cornea well developed. Antennule: peduncle moderately long, third segment about as long as second, each with prominent dorsal distal spine, basal segment with 3 or 4 spinules on dorsal distal margin; stylocerite moderately long; outer flagellum setiferous, exceeds antennal scale slightly, inner somewhat longer. Antenna: scale shorter than telson, lamina exceeds spine; basicerite with 2 strong lateral spines; peduncle moderately long; flagellum a little shorter than body. Third maxilliped: very long, very stout; antepenultimate segment, line of 20–30 groups (2–4) of spinules, also group of about 12 spinules on upper distal margin; epipod. Pereiopods: I shorter than third maxilliped, as stout; ischium with lamina; merus, line of 12–14 groups (2–4) of spines, group of about 12 spinules on upper distal margin; chelate; epipod; II longer than I, slender; ischium lamellar expansion on proximal fourth, with tuft of setae; carpus, 7 segments; chelate; epipod; III shorter than II, stouter; merus, 1 spine; propodus, 26–28 spinules, 1 or 2 rows; dactylus stout, about 0.18 propodus length, 5 or 6 spines, bifid; epipod; IV shorter than III, as stout; merus, 1 spine; propodus, about 22 spinules, 1 or 2 rows; dactylus stout, about 0.23 propodus length, 5 or 6 spines, bifid; V shorter than IV, as stout; merus, 1 spine; propodus, about 22 spinules, 1 or 2 rows; dactylus moderately stout, about 0.25 propodus length, 5 or 6 spines, bifid. Abdomen: faint transverse dorsal sulcus on second somite; pleuron of fourth with moderate ventral spine; posterolateral margins of fourth and fifth widely recessed at articular knobs; fifth with strong posterolateral spine; sixth stout, a little longer than fifth, with strong posteroventral spine; telson wide, tapering to acute tip, 4 pairs dorsolateral spines; both uropods same length, exceeding telson.

Color Varies with surroundings, semitransparent with kelp-brown tinge; blue stripes on dactyli and propodi, occasionally on other segments of pereiopods and part of carapace when among brown algae (109). Specimens taken at Brockton Point among tube worms mainly were fairly transparent, spotted with deep brown and blue tipped pereiopods; most of carapace of an ovigerous female was opaque pinkish white, with striped grey and blue legs and brilliant green abdomen; another specimen dark brown, marked with blue (109). In California, uniform light crimson or scarlet (232).

Distinctions Separated from the other coastal shrimp, *H. stimpsoni,* which also has a ventral spine on the pleuron of the fourth abdominal somite and epipods on pereiopods I–III, by very short rostrum, normally without ventral spines; antennal scale shorter than telson; long, stout third maxilliped, which exceeds antennal scale by over half length of maxilliped.

Maximum lengths Males: carapace 11.1 mm, total 49 mm; females: carapace 15.0 mm, total, 62 mm.

Range Attu, Aleutian Islands, to San Francisco Bay (219); intertidal to 128 m.

The first published record of the species from British Columbia waters was in 1864 (25), based on material collected by J. K. Lord in Esquimalt Harbour, in 1862.

Biology and economics *H. brevirostris* is probably one of the most common intertidal shrimps along the British Columbia coast. Specimens collected by E. L. Bousfield around Vancouver Island, at Point Roberts and White Rock, and identified by the present author, occurred at temperatures 10.3–18.0°C and salinities 9.1–31.3‰ (42). Ovigerous females, 3.8–9.8 mm carapace length, were found January, March, April, May, June, and August. The species has 2 parasites; the branchial isopod, *Bopyroides hippolytes* (225, 89), and the rhizocephalan, *Sylon hippolytes* (239). There is a description of the first stage larva (197). *H. brevirostris* was utilized commercially in San Francisco Bay in the last century (77).

GLOSSARY

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Many definitions from Chace and Hobbs (71), and Hart (113)

Abdomen – the part of the body posterior to cephalothorax, the "tail."
Abyssal – pertaining to great depths, below 2745 m.
Acute – tapering to sharp point.
Adaptation – the condition of showing fitness for a particular environment.
Annulations – spaced rings on a segment of appendage, not articulated, yet with flexibility.
Antenna (plural *antennae*) – the more lateral of the two paired flagellate appendages projecting anteriorly from anterior end of the body.
Antennal peduncle – basal segments of the antenna, from which the flagellum arises.
Antennal region – area on lateral surface of the carapace posterior to and encompassing antennal spine.
Antennal scale – the laterally rigid lamellar exopod of the antenna.
Antennal spine – short spine usually present on or near anterior margin of carapace just ventral to orbit.
Antennular peduncle – basal segments of antennule from which the flagella arise.
Antennule – inner of two paired flagellate appendages projecting from anterior end of body.
Antepenultimate – third from last, as a segment of appendage.
Anterior – of, pertaining to, or toward the front.
Anterolateral – front side of a structure.
Apical – at the distal end.
Appendix interna (plural *appendices internae*) – slender rodlike flap on inner margin of endopod of the second to fifth pleopods of shrimps.
Appendix masculina (plural *appendices masculinae*) – flap inserted between appendix interna and inner margin of endopod of the second pleopod in most male shrimps.
Arthrobranch – gill attached to the articular membrane between body wall and coxa of an appendage.
Articular knob – swelling or irregularity in the shell at a joint of an appendage, or between abdominal somites at the juncture of pleuron and tergum.
Articular membrane – the uncalcified integument, permitting movement of the shell, as between segments of a pereiopod, or between abdominal somites.
Ascending – growing or directed upward.

Basicerite – second or distal segment of the protopodite of antenna, to which are attached the scale and peduncle.
Basis (plural *bases*) – second segment from the proximal end of a typically 7-segmented appendage.
Bathymetric – pertaining to depths of water, as in distribution.
Bathypelagic – zone in the open ocean deeper than 1000 m below the surface, or pertaining to its inhabitants.
Bifid – split in two, as in spines.
Bifurcate – forked, divided into two branches.
Bioluminescence – production of light by living organisms; occurs in several genera of shrimps.
Biometrician – specialist who applies statistics to the study of shrimps or other organisms.
Biramous – having two branches, as a pleopod.
Branchial – pertaining to the gills.
Branchial region – portion of carapace overlying the branchial cavity.
Branchiostegal spine – spine on or near anterolateral margin of the carapace of some shrimps, ventral to antennal spine and dorsal to pterygostomian spine.
Bristle – indefinite term for short, stiff seta or spinule.

Brush – clump or band of setae or spinules, usually on distal flexor margin of propodus of fifth pereiopod; used by shrimp for grooming.

Carapace – "head shield" covering the cephalothoracic somites of the body.
Carcinologist – specialist who studies shrimps or other crustaceans.
Cardiac region – dorsolateral region of carapace bounded anteriorly by gastric region and laterally by branchial regions.
Carina (plural *carinae*) – keel, or ridge.
Carinate – having a carina, keeled.
Carpus (plural *carpi*) – fifth segment from proximal end of a typically 7-segmented appendage.
Catalepsis – bridging of the dorsal surface of a shrimp, as if telson is about to touch rostrum; a defensive position.
Category – see *Taxonomic category.*
Cephalothorax – fused anterior part of the body bearing all body appendages except pleopods and uropods.
Cervical sulcus (or *groove*) – groove or series of grooves sometimes present on carapace; mesially transverse, laterally oblique, and separates gastric and hepatic regions from cardiac and branchial regions.
Chela (plural *chelae*) – claw formed by the two distal segments of a pereiopod, in which the movable finger or dactylus opposes a fixed finger formed by the distal extension of propodus.
Chelate – bearing a chela.
Cheliped – pereiopod bearing a chela.
Chitin – constituent of the shell or integument of a shrimp.
Chromatophore – a cell (simple or branched), usually in shell (cuticular or subcuticular), containing pigment granules, usually capable of being dispersed or concentrated.
Circumboreal – pertaining to geographical distribution that encompasses all marine areas in colder parts of the northern hemisphere.
Commensal – one of two different species of animals living in close association, so that one species derives an advantage and the other has neither an advantage nor a disadvantage.
Compressed – flattened from side to side, or laterally.
Congeners – species belonging to the same genus.
Continental shelf – band of sea bottom between the low tide mark and about 180 m.
Continental slope – portion of sea bottom between 180 and about 1800 m.
Cornea – faceted portion of eye.
Coxa (plural *coxae*) – first or proximal segment of a typically 7-segmented appendage.
Crested – with elevated and irregular or toothed ridge.
Cuticular – pertaining to, or part of the integument or shell; structurally, cuticle is complex, made up of four layers of differing chemical composition.

Dactylus (plural *dactyli*) – seventh or terminal segment of a typically 7-segmented appendage.
Decurved – curved downward.
Deflected – bent or turned, usually abruptly.
Demersal – living on or near the bottom.
Dentate – with sharp spines directed outward from margin.
Depressed – flattened from above downwards, or dorsoventrally.
Dermal – see *Cuticular.*
Descending – directed downward.
Diagnosis (plural *diagnoses*) – in taxonomy, a statement of important and essential characters, distinguishing one category from all other related and similar categories.

Diel migration – referring to migration, normally with change of depth, during the 24-hour day.
Distal – situated away from the base or point of attachment.
Distolateral – outer side or margin of an appendage, e.g. uropod.
Diurnal – referring to activity by daylight.
Dorsad – toward dorsal surface.
Dorsal – of, or pertaining to, the back or upper surface.
Dorsolateral – upper side of a structure.
Dorsolaterally – from upper to lower surface or margin.

Ecdysis – see *Molting.*
Ecology – the study of marine life as related to its environment.
Ecosystem – collectively, all organisms in a community plus environmental factors.
Ectoparasite – parasite on the external surface of its host.
Egestion – process of eliminating indigestible material, usually by way of the anus.
Egg – spheroidal body produced by ovary of female, containing embryo and yolk as food supply.
Egg-bearing – see *Ovigerous.*
Elongate – lengthened, longer than deep or wide.
Emarginate – having a slight notch or indentation.
Endoparasite – an internal parasite.
Endopod – inner branch of biramous appendage, especially one arising from protopodite of pleopod.
Environment – the total of all physical, chemical, and biological factors to which shrimps are subjected.
Epibiont – animal that lives on the surface of another animal, but not as a parasite.
Epigastric spine – a median dorsal spine posterior to rostrum, on gastric region; sometimes has the appearance of a rostrum, e.g. Pasiphaeidae.
Epipelagic – zone usually in the open ocean from surface to 200 m, or referring to its inhabitants.
Epipod – respiratory process arising from coxa of a thoracic appendage; usually elongate and flat, but may be folded; has taxonomic value.
Estuary – area where river water meets and dilutes seawater.
Euryhaline – able to withstand a wide range of salinities.
Eurythermal – able to withstand a wide range of temperatures.
Exopod – outer branch of biramous appendage, arising from basis or protopodite; those on thoracic appendages of some shrimps have swimming function; of taxonomic value.
Extensor margin – outer or longer margin of a flexed appendage.
Eyepiece micrometer – linear scale mounted in element of microscope near eye, enabling measurement of small shrimps and their structures.
Eyestalk – peduncle or unfaceted portion of eye bearing cornea.

Family – taxonomic category including one or more genera with certain phylogenetic characters in common.
Fauna – collectively the animals inhabiting an area.
Fecundity – relative number of eggs, sperm, or young produced by a shrimp.
Finger – one of terminal elements of a chela; movable finger is the dactylus; fixed finger is the terminal extension of propodus.
Fissure – separation of shell by sulcus; occurs on carapace between antennal and postorbital spines of some crangonid shrimps.
Fixed finger – see *Finger.*
Flagellum (plural *flagella*) – the multiarticulate, usually whiplike terminal portion of antennule or antenna.

Flexor margin – inner or shorter margin of flexed appendage.
Fossorial – pertaining to burrowing or digging shrimps, e.g. some species of *Crangon* or *Argis.*
Frontal region – anterior area of carapace lying between orbits and bounded posteriorly by gastric region.
Furcate – forked or branched.

Gastric region – principal dorsolateral or mesial area on carapace lying anterior to cervical groove, bounded posteriorly by cardiac region, laterally by branchial and hepatic regions, and anteriorly by frontal and orbital regions.
Gastrohepatic gland – digestive and storage gland in shrimps; also termed hepatopancreas.
Gastro-orbital carina – main lateral carina on shrimps of genus *Notostomus.*
Genus (plural *genera*) – taxonomic category including one or more species with certain fundamental characters in common.
Gill cavity – space on either side of cephalothorax containing gills.

Habitat – a particular place where a shrimp lives, e.g. exposed sandy beach.
Hand – sometimes used as name for chela.
Handbook – in taxonomy, a publication designed primarily as an aid to field and laboratory identification.
Hepatic carina – carina located above hepatic region, generally in line with antennal and suprabranchial carinae.
Hepatic region – paired anterolateral areas on carapace bounded posteriorly by branchial region, mesially by gastric region, and anteriorly by antennal region.
Hepatic spine – lateral spine on carapace near anterior margin of hepatic region.
Hermaphrodite – a shrimp capable of functioning both as a male and a female during its life.
Holotype – the single specimen designated as "the type" by the original author at the time of publication of the original description.
Host – shrimp parasitized by an organism of another species.

Incisor process – cutting process on mandible; widely separated from molar or grinding process in some shrimps, e.g. Pandalidae, in close proximity in others, e.g. Oplophoridae.
Infra-gastro-orbital carina – short lateral carina ventral to gastro-orbital carina on carapace of shrimps of genus *Notostomus.*
Intersex – see *Transitional.*
Intertidal zone – portion of sea bottom between high and low tide lines.
Inverted – pertaining to chela of first pereiopod of shrimps of genus *Betaeus,* where movable finger or dactylus is ventral in position.
Ischium (plural *ischia*) – third segment from proximal end of a typically 7-segmented appendage.

Keeled – see *Carinate.*
Key – tabulation of diagnostic characters of species (or genera, etc.) arranged in alternative statements, facilitating identification.

Lamella (plural *lamellae*) – thin flat plate or scale.
Lamina (plural *laminae*) – blade or expanded part of scale or appendage segment.
Larva (plural *larvae*) – general term for early stages of shrimps after hatching from the egg, morphologically quite different from adult.
Lash – flexible distal portion of exopod on third maxilliped of shrimps of family Crangonidae.
Lateral – located away from midline; pertaining to the side.

Life history — series of morphological changes and activities of a shrimp from time of fertilization until death.
Littoral — shallow portion of the sea bottom extending from the low tide mark to 200 m.
Lower submedian spine — lateral spine on carapace, between submedian and hepatic spines of *Mesocrangon munitella.*
Luminescent (luminous) organs — areas producing light on the shrimp body; internal as part of gastro-hepatic gland (organ of Pesta), or as dermal photophore.

Mandible — one of the heavy calcified jaws lying anterior to (beneath in ventral view) other mouth parts.
Manus — another term for chela.
Material — in taxonomy, the sample available for study.
Maxilla (plural *maxillae*) — one of two paired appendages in mouth region, posterior to (above in ventral view) mandible.
Maxilliped — one of three paired appendages posterior to the maxillae; most prominent pair, the third or outer maxillipeds elongate in shrimps, resembling pereiopods; in penaeidean shrimps, second maxillipeds also prominent.
Median — on or near the plane dividing a shrimp into two mirror-image parts.
Membranous — pertaining to the very soft, fragile integument of some shrimps.
Meristic — of characters involving numbers or counts.
Merus (plural *meri*) — fourth segment from proximal end of a typically 7-segmented appendage.
Mesial — referring to inner margins or surfaces, closer to midline than sides.
Mesopelagic — zone in the open ocean 200–1000 m below the surface, or pertaining to its inhabitants.
Metamorphosis — period of abrupt transformation from one distinctive stage in the life history to another, especially from larva to adult.
Molar process — see *Incisor process.*
Molting — periodic shedding of shell to permit an increase in size and/or change of form.
Morphology — study of the form of a shrimp considered as a whole or in its gross aspects.
Mouth parts — mandibles, maxillae, and maxillipeds; used for obtaining, handling, and processing food.
Movable spine — spine set in socket; depressible, by movement towards basal structure such as carapace or segment of appendage.

Nauplius (plural *nauplii*) — free-swimming, microscopic larval stage, after hatching from egg, characteristic of penaeidean shrimps.

Obliquely erect — directed obliquely, more or less at 45° to basal surface.
Obsolete — only faintly apparent or absent.
Obtuse — blunt at tip.
Orbit — the eye socket.
Orbital region — paired areas on carapace adjacent to orbits.
Organ of Pesta — one of several processes on the gastrohepatic gland, modified to produce light; found on species of genus *Sergestes.*
Ovary — female reproductive organ, producing ova.
Ovigerous — pertaining to the condition of, or a female, carrying external fertilized eggs.
Ovum (plural *ova*) — mature, but unfertilized egg.

Palm — portion of a chela proximal to the fingers.
Palp — segmented, sensory structure attached to mandible; its presence or absence, and number of segments, of taxonomic value.
Parasite — an organism, deriving its sustenance from a shrimp, the host.

Paratype – a specimen other than the holotype, examined by the author at the time of the original description, and so designated by the author.

Peduncle – stalklike structure supporting another structure or organ; in shrimps, main reference to part of antennule or antenna; sometimes another term for eyestalk.

Pelagic – zone above the sea bottom; or living free from the bottom.

Penultimate – second from last, as a segment of appendage.

Pereiopod – one of five pairs of posterior appendages or legs attached to the cephalothorax.

Pericardial cavity – special cavity or sinus containing heart.

Pesta – see *Organ of Pesta.*

Petasma – complex genital structure attached to the inner margins of protopodites of the first pair of pleopods on male penaeidean shrimps.

Photophore – specialized organ in some shrimps, capable of producing light, with or without lens.

Phylogeny – evolutionary relationships and lines of descent in any taxonomic category.

Pinnate seta – see *Plumose seta.*

Plankton – free-floating, small, living plants (phytoplankton) and animals (zooplankton).

Pleopod – one of the paired appendages typically arising from each of first five abdominal somites; primarily used for swimming in shrimps.

Pleurobranch – gill attached to the lateral wall of thorax, just above origin of basal segment of appendage.

Pleuron (plural *pleura*) – one of the paired lateral flaps on each side of first five abdominal somites.

Plumose seta (plural *setae*) – seta, with distolateral processes, resembling a feather.

Podobranch – gill arising from an epipod.

Podomere – term used by some authors for segment of an appendage, such as merus of a pereiopod.

Postcervical sulcus – ancillary sulcus, posterior to and converging with, main cervical sulcus on carapace of genus *Bentheogennema.*

Posterior – of, or pertaining to the rear end.

Posteroventral – on rear lower side of structure.

Posthepatic carina – an oblique carina along posterior margin of hepatic sulcus, on carapace of genus *Notostomus.*

Prehensile – adapted for grasping or seizing.

Propodus (plural *propodi*) – sixth or penultimate segment of a typically 7-segmented appendage.

Protandrous – hermaphrodites that function as males before females.

Protista – general category that includes all unicellular algae, protozoans, bacteria, etc.

Protogynous – hermaphrodites that function as females before males.

Protopodite – fused proximal segments (coxa and basis) of an appendage such as pleopod, usually with endopod and exopod.

Protozoea – free-swimming larval stage, after nauplius, characteristic of penaeidean and some caridean shrimps.

Proximal – toward or near a point of attachment.

Pterygostomian spine – spine located at anterolateral region of carapace.

Pubescence – covering of short, fine setae, easily rubbed off.

Rostral formula – number of spines on dorsal surface of rostrum (including those on carapace)/number of ventral spines.

Rostral spine – median spine resembling a rostrum, adjacent to frontal margin of carapace on shrimps of genus *Argis.*

Rostrum (plural *rostra*) – the "head spine" or anterior projection of cephalothorax between the eyes of shrimps.

Scale – see *Antennal scale.*

Section – taxonomic category used with shrimps, between suborder and family, e.g. Caridea.

Sensu lato (s.l.) – "in a broad sense"; pertaining to a taxon, e.g. genus, which by its diagnosis includes all relevant species.

Sensu stricto (s.s.) – "in a narrow sense"; pertaining to a taxon, e.g. genus, which by its diagnosis includes a limited number of species.

Series – in penaeidean shrimps, taxonomic category, between subfamily and genus, e.g. Benthesicymae.

Serrate – notched or with spines along edge.

Seta (plural *setae*) – hairlike or needlelike projection from shell of shrimps; may be simple or plumose.

Setiferous – bearing setae, as an appendage.

Setose – bearing bristles.

Sinus – any space or cavity in body tissues; also, refers to broad concavity in margin of shell.

Somite – body segment, especially of the abdomen.

Sonic scattering layer – an aggregation of pelagic organisms that provides echoes when subjected to sound waves from the surface; pelagic shrimps contribute to echoes.

Species – groups of actually (or potentially) interbreeding natural populations, reproductively isolated from other such groups.

Spine – sharp, stiff, fairly robust protuberance on body or appendages.

Spinose – bearing spines.

Spinule – small, or secondary spine; may be shorter or longer than spine, but usually more flexible.

Sternite – one of five transverse fused plates of sternum indicating basic segmentation of cephalothorax.

Sternum – ventral surface of cephalothorax between coxae of pereiopods.

Styliform – in the shape of a spear or needle.

Stylocerite – spine arising from lateral margin of first segment of antennular peduncle.

Subchela – prehensile structure in family Crangonidae, where terminal segment (dactylus) folds back against the more robust penultimate segment (propodus).

Subequal – nearly but not quite equal.

Suberect – nearly erect, i.e. perpendicular to basal surface.

Subfamily – taxonomic category between family and genus; recognized by name ending in *inae.*

Subgenus – optional taxonomic category between genus and species.

Sublittoral zone – sea bottom from low tide mark to about 180 m; another use, from 50–180 m.

Submedian spine – lateral spine between median and hepatic spines on carapace.

Suborbital spine – spine on anterior margin of carapace, below eye.

Subspecies – a geographically or physiologically defined aggregate of local populations differing taxonomically from other such subdivisions of the species.

Sulcate – grooved.

Sulcus – a groove.

Superfamily – in shrimps, taxonomic category between section and family, recognized by name usually ending in "oidea."

Supraorbital spine – spine adjacent to anterior margin of carapace, above eye.

Swimmeret – see *Pleopod.*

Synonym – one of two or more different names for the same taxonomic category.

Synonymy – chronological list of scientific names applied to a given taxonomic category, including authors of the names and publication dates.

TAC – total allowable catch; employed in shrimp management.
Tail fan – as a unit, telson and two pairs of uropods.
Taxon (plural *taxa*) – any taxonomic unit such as section, genus, and species.
Taxonomic category – unit into which shrimps are classified, such as family, genus, and subspecies.
Taxonomy – the scientific classification of organisms.
Telson – the terminal somite of abdomen; part of tail fan.
Tergum (plural *terga*) – the dorsal (and dorsolateral) portion of each of first five abdominal somites between pleura.
Terminal – at the end.
Terminal pegs – minute or microscopic projections of dactylus and propodus on first pereiopod, with limited function as chela, e.g. in *Pandalus.*
Testis (plural *testes*) – male reproductive organ, producing sperm.
Thelycum (plural *thelyca*) – specialized genital structure of the three posterior sternites in female penaeidean shrimps.
Thorax – see *Cephalothorax.*
Tip – the distal end.
Transitional – refers to a shrimp in the course of changing sex.
Transverse – lying across.
Trifid – cleft to form three spines.
Truncate – terminating abruptly, as if cut off.
Tubercle – knoblike process; tip usually blunt.
Type – see *Holotype, Paratype.*
Type locality – locality at which the type specimens were collected.

Uropod – one of paired appendages attached to sixth abdominal somite, part of tail fan.

Ventrad – toward the ventral surface.
Ventral – underside, that which is normally facing downwards.
Viscera – internal organs of shrimp.

Walking leg – any nonchelate pereiopod.

Zoea – free-living larval stage, following protozoea, present in all shrimps.
Zooplankton – see *Plankton.*

GAZETTEER

GAZETTEER

General locations, latitudes, and longitudes of most places mentioned in the text. Minutes of latitude or longitude where given are separated by a decimal point from the degrees. In a few cases tenths of a minute are shown following a second decimal point.

Also included are 13 stations of the *Albatross*, and 2 stations of the *William J. Stewart.*

Active Pass	South Strait of Georgia	48.51 N	123.18 W
Agate Beach	South Vancouver Island	48.213 N	123.437 W
Allison Harbour	Central British Columbia	51.03 N	127.30 W
Amphitrite Point	West coast Vancouver Island	48.55 N	125.32 W
Anadyr, Gulf of	Bering Sea, eastern USSR	64.00 N	178.00 W
Anthony Island	Southwest Queen Charlotte Islands	52.05 N	131.13 W
Aomori Bay	Northern Honshu, Japan	40.50 N	140.43 E
Attu Island	Aleutian Chain	52.55 N	173.11 E
Barents Sea	Arctic, western Russia	75.00 N	40.00 E
Barkley Sound	West coast Vancouver Island	48.50 N	125.20 W
Bella Bella	Central British Columbia	52.09 N	128.07 W
Bellingham Bay	Northern Washington State	48.42 N	122.34 W
Bering Strait	Between USSR and Alaska	66.00 N	169.00 W
Bird Island	Shumagin Islands, Alaska Peninsula	54.49 N	159.45 W
Brentwood Bay	South Vancouver Island	48.356 N	123.285 W
Brockton Point	Vancouver Harbour	49.18 N	123.07 W
Bunsby Islands	Kyuquot Sound, west Vancouver Island	50.06 N	127.32 W
Burke Channel	Central British Columbia	52.15 N	127.20 W
Burnaby Narrows	Southeast Queen Charlotte Islands	52.22 N	131.21 W
Burrard Inlet	Southern British Columbia	49.18 N	123.00 W
California, Gulf of	East of Baja California	26.00 N	110.00 W
Calvert Island	Central British Columbia	51.35 N	128.00 W
Canoe Bay	South Vancouver Island	48.41 N	123.24 W
Cape Cod	Massachusetts	42.00 N	70.01 W
Cape Flattery	Northwest Washington State	48.22 N	124.42 W
Cape Lisburne	Chukchi Sea, northwest Alaska	68.54 N	166.18 W
Cape Navarin	Western Bering Sea	62.16 N	179.10 E
Cape Olyutorsky	Western Bering Sea	59.58 N	170.25 E
Cape St. James	South Queen Charlotte Islands	51.56 N	131.01 W
Cape Scott	Northwest end Vancouver Island	50.47 N	128.25 W
Cedros Island	West coast Baja California	28.15 N	115.15 W
Chatham Sound	Northern British Columbia	54.30 N	130.35 W
Checleset Bay	West coast Vancouver Island	50.04 N	127.43 W
Chichagof Island	Southeast Alaska	57.25 N	135.52 W
Chukchi Sea	Arctic between Alaska and Russia	68.00 N	170.00 W
Clio Channel	Central British Columbia	50.35 N	126.25 W
Commander Islands	East of Kamchatka, USSR	55.00 N	166.00 E
Comox	East coast Vancouver Island	49.40 N	124.55 W

Comox Bar	East coast Vancouver Island	49.39 N	124.52 W
Constantine Harbor	Entrance of Prince William Sound	60.20 N	146.39 W
Coronation Gulf	Between Victoria Island and Northwest Territories	68.00 N	112.00 W
Cortes Bank	Southwest coast California	32.27 N	119.08 W
Cypress Bay	West coast Vancouver Island	49.17 N	125.53 W
Deep Cove	Burrard Inlet, south British Columbia	49.19 N	122.56 W
Departure Bay	Near Nanaimo, southern Strait of Georgia	49.12 N	123.57 W
Dixon Entrance	Between Queen Charlotte Islands and Alaskan islands	54.30 N	132.00 W
Dixon Harbor	Near Cape Spencer, southeast Alaska	58.22 N	136.51 W
Douglas Channel	Northern British Columbia	53.34 N	129.12 W
Drake Bay	Central coast California	38.01 N	122.55 W
Duke Point	Near Nanaimo, southern Strait of Georgia	49.09 N	123.53 W
Durban	East coast South Africa	29.53 S	31.00 E
Dutch Harbor	Unalaska Island, Aleutian Chain	53.55 N	166.36 W
Edye Pass	Northern British Columbia	54.03 N	130.33 W
Effingham Inlet	Barkley Sound, west Vancouver Island	49.00 N	125.11 W
English Bay	Near Vancouver, B.C.	49.17 N	123.14 W
Entry Point	North Queen Charlotte Islands	54.027 N	132.12 W
Esperanza Inlet	West coast Vancouver Island	49.50 N	127.00 W
Esquimalt Harbour	South Vancouver Island	48.26 N	123.24 W
Estevan Point (Esteban)	Middle west coast Vancouver Island	49.22 N	126.32 W
Faeroe Islands	North of Great Britain	62.00 N	7.00 W
False Narrows	South Vancouver Island	49.08 N	123.46 W
Fife Point	Northeast coast Queen Charlotte Islands	54.04 N	131.40 W
Fort Rupert	North Vancouver Island	50.42 N	127.24 W
Foxe Basin	Between Baffin Island and Northwest Territories	67.30 N	67.30 W
Friday Harbor	San Juan Islands, Washington State	48.32 N	123.01 W
Gabon	Africa	00.15 N	9.40 E
Gabriola Island	South Strait of Georgia	49.10 N	123.50 W
Gibraltar	Off southern Spain	36.09 N	5.21 W
Gonzales Point	Near Victoria, Vancouver Island	48.25 N	123.18 W
Granby Bay	Observatory Inlet, northern British Columbia	55.22 N	129.49 W
Grant Bay	Northwest Vancouver Island	50.286 N	128.05 W
Grays Harbor	South coast Washington State	46.56 N	124.00 W
Haaksvold Point	Central British Columbia	51.58 N	127.427 W

Hecata Bank	Off central Oregon coast	44.12 N	124.51 W
Hecate Strait	Between Queen Charlotte Islands and coast islands	53.00 N	131.00 W
Hernando Island	Northeast Strait of Georgia	49.476 N	124.568 W
High Island	Near entrance to Esperanza Inlet, Vancouver Island	49.508 N	127.07 W
Hokkaido Province (Island)	Northern Island, Japan	43.00 N	143.00 E
Honshu Island	Largest island, Japan	35.00 N	129.00 E
Hood Canal	Off Puget Sound, Washington State	47.33 N	123.00 W
Howe Sound	South Strait of Georgia	49.26 N	123.20 W
Hudson Bay Pass	Dundas Islands, northern British Columbia	54.28 N	130.54 W
Hudson Rock	Near Nanaimo, southern Vancouver Island	49.134 N	123.556 W
Iliuliuk Harbor	Aleutian Islands, Alaska	53.53 N	166.30 W
Indus River Mouth	Southeast Pakistan	24.00 N	68.12 E
Isla San Martin	Baja California	30.31 N	116.10 W
Jesse Island	Near Nanaimo south Strait of Georgia	49.12 N	123.57 W
Jordan River	Vancouver Island on Juan de Fuca Strait	48.25 N	124.03 W
Juan de Fuca Strait	South Vancouver Island	48.25 N	124.03 W
Kachemak Bay	Cook Inlet, Alaska	59.36 N	151.22 W
Kamchatka	Eastern USSR	55.00 N	160.00 E
Kingcome Inlet	Central British Columbia	50.55 N	126.32 W
Knight Inlet	Central British Columbia	50.40 N	126.00 W
Korea	East Asia	37.50 N	128.00 E
Korea Strait	Between Korea and Japan	34.40 N	129.10 E
Korsfjorden	Southwest Norway	60.12 N	5.15 E
Kyuquot Sound	West Vancouver Island	50.03 N	127.10 W
La Pérouse Bank	Off southwest coast Vancouver Island	48.35 N	125.48 W
Laptev Sea	Northern USSR	76.00 N	125.00 E
Lopez Island	San Juan Islands, Washington State	48.30 N	122.54 W
Loughborough Inlet	South British Columbia	50.30 N	125.35 W
Lund	Northeast, Strait of Georgia	49.59 N	124.46 W
Maine, Gulf of	Between Nova Scotia and Maine	43.30 N	68.00 W
Manhattan Beach	Near Tillamook Bay, Oregon	45.38 N	123.57 W
Maritime Territory	Southeast part of USSR	45.00 N	135.00 E
Massachusetts Bay	East of Boston, Maine	42.20 N	70.45 W
Masset	North Queen Charlotte Islands	54.01 N	132.09 W
Masset Inlet	North Queen Charlotte Islands	53.43 N	132.18 W
McIntyre Bay	North Queen Charlotte Islands	54.00 N	132.00 W
Monterey	Central California	36.35 N	121.55 W
Montevideo	Southern Uraguay	34.55 S	56.10 W
Moresby Island	Southern island, Queen Charlotte Islands	53.00 N	132.00 W
Morro Bay	Central California	35.24 N	120.50 W

Murman coast	Western Arctic, USSR	69.00 N	37.00 E
Mutsu Bay	Northern Honshu, Japan	41.11 N	141.00 E
Naden Harbour	North Queen Charlotte Islands	54.00 N	132.30 W
Nagasaki	Kyushu Island, south Japan	32.45 N	129.52 E
Namu	Central British Columbia	51.52 N	127.50 W
Nanaimo Harbour	Southeast Vancouver Island	49.10 N	123.56 W
Nanaimo River Estuary	Southeast Vancouver Island	49.09 N	123.54 W
Nanoose Bay	South Strait of Georgia	49.16 N	124.10 W
Newcastle Island Passage	Near Nanaimo, south Strait of Georgia	49.11 N	123.57 W
Newport Harbor (Beach)	Southern coast, California	33.38 N	117.55 W
Nootka Sound	West Vancouver Island	49.35 N	126.35 W
North Sea	Between Great Britain and Europe	55.00 N	3.00 E
Norton Sound	South of Seward Peninsula, Alaska	64.00 N	164.00 W
Novaya Zemlya	Arctic Ocean, northwest USSR	73.00 N	55.00 E
Nunivak Island	Bering Sea, Alaska	60.00 N	166.00 W
Okhotsk Sea	Between mainland and Kamchatka, east USSR	55.00 N	150.00 E
Onagawa Bay	Northeast coast Honshu, Japan	38.25 N	141.45 E
Parksville	Vancouver Island shore, Strait of Georgia	49.194 N	124.19 W
Parry Bay	Near Victoria	48.22 N	123.31 W
Passage Island	Howe Sound mainland shore, Strait of Georgia	49.205 N	123.184 W
Patagonia	Southern Argentina	45.00 S	65.00 W
Pender Harbour	Mainland shore, Strait of Georgia	49.38 N	124.00 W
Petersburg	Southeast Alaska	56.48 N	132.57 W
Peter the Great Bay	Near Vladivostok, USSR	42.40 N	132.00 E
Pipers Lagoon	Near Nanaimo, Strait of Georgia	49.135 N	123.57 W
Point Arena	Northern California	38.573 N	123.444 W
Point Barrow	North Alaska	71.32 N	156.30 W
Point Franklin	North Alaska	70.53 N	159.00 W
Point Levashev (f)	Unalaska Island, Aleutian Chain	53.34 N	166.31 W
Point Loma	Near San Diego, California	32.399 N	117.145 W
Point Roberts	West of Boundary Bay	48.58 N	123.05 W
Point Sur	Central California	36.184 N	121.54 W
Porcher Island	Northern British Columbia	54.00 N	130.35 W
Port San Juan	Southern Vancouver Island	48.32 N	124.27 W
Port Simpson	Northern British Columbia	54.34 N	130.23 W
Prescott Passage	Northern British Columbia	54.04 N	130.36 W
Pribilof Islands	Bering Sea	57.00 N	170.00 W
Prince William Sound	North Gulf of Alaska	60.30 N	147.00 W
Puget Bay	Kenai Peninsula, Alaksa	60.00 N	148.29 W
Puget Sound	Northwest Washington	47.50 N	122.30 W
Queen Charlotte Sound	Central British Columbia	51.20 N	129.00 W
Queen Charlotte Strait	Between northern Vancouver Island and mainland	50.40 N	127.00 W

Race Rocks	South Vancouver Island	48.18 N	123.32 W
Rat Island	Aleutian Chain	51.48 N	178.15 E
Refuge Cove (Bay)	Northern British Columbia	54.045 N	130.32 W
Restoration Bay	Central British Columbia	52.01 N	127.39 W
Resurrection Bay	Kenai Peninsula, Alaska	60.00 N	149.22 W
Rivers Inlet	Central British Columbia	51.39 N	127.30 W
Saanich Inlet	South Vancouver Island	48.38 N	123.30 W
Saanich Peninsula	South Vancouver Island	48.40 N	123.25 W
Sado Island	West Honshu, Japan	38.00 N	138.45 E
Sagami Bay	Southeast Honshu, Japan	35.00 N	139.30 E
St. Lawrence, Gulf of	East coast Canada	48.00 N	62.00 W
St. Michael	Norton Sound, Alaska	63.29 N	162.02 W
San Diego	Southern California	32.43 N	117.09 W
San Francisco Bay	Central California	37.48 N	122.21 W
San Juan Islands	Archipelago, Washington	48.35 N	122.50 W
San Luis Obispo Bay	Central California	35.16 N	120.40 W
San Nicolas Island	Off southern California	32.15 N	119.30 W
Santa Catalina Island	Off southern California	33.25 N	118.25 W
Sargasso Sea	East of Florida	30.00 N	55.00 W
Saturna Island	South Strait of Georgia	48.47 N	123.10 W
Sealion Rock	Central Washington State	47.27 N	124.24 W
Sea of Japan	Between Korea and Japan	40.00 N	135.00 E
Second Narrows	Vancouver Harbour	49.18 N	123.00 W
Seward	Kenai Peninsula, Alaska	60.065 N	149.238 W
Seymour Inlet	Central British Columbia	51.04 N	127.24 W
Sheep Bay	Prince William Sound, Alaska	60.40 N	146.00 W
Shelter Cove	Northern California	40.01 N	124.04 W
Shoal Harbour	South Vancouver Island	48.40 N	123.24 W
Sidney	South Vancouver Island	48.38 N	123.23 W
Sitka	Southeast Alaska	57.03 N	135.14 W
Skidegate Channel	Between main Queen Charlotte Islands	53.09 N	132.17 W
Smith Sound (Inlet)	Central British Columbia	51.16 N	127.45 W
Sooke Harbour	South Vancouver Island	48.22 N	123.45 W
Spitzbergen	Arctic, north Norway	78.00 N	19.00 E
Stephens Island	Northern British Columbia	54.09 N	130.40 W
Strait of Georgia	Between Vancouver Island and mainland	49.20 N	124.00 W
Sydney Inlet	West coast Vancouver Island	49.20 N	126.15 W
Tartar Strait	Between Sakhalin and southeast USSR	50.00 N	141.00 E
Tasu Sound	West coast Queen Charlotte Islands	52.51 N	132.08 W
Tatchu Point	West coast Vancouver Island	49.52 N	127.09 W
Tava Island	Southeast Alaska	56.50 N	135.29 W
Texada Island	Central Strait of Georgia	49.40 N	124.23 W
Tofino	West coast of Vancouver Island	49.09 N	125.54 W
Tokyo Bay	Southeastern Honshu, Japan	35.30 N	139.52 E
Toyama Bay	West coast of Honshu, Japan	36.50 N	137.10 E
Ucluelet	West coast Vancouver Island	48.56 N	125.34 W

Vladivostok	Southeast USSR	43.09 N	131.53 E
Welcome Harbour	Northern British Columbia	53.595 N	130.383 W
White Rock	Boundary Bay, south British Columbia	49.01 N	122.48 W
Wrangell Island	Southeast Alaska	56.20 N	132.10 W
Yakan Point	North Queen Charlotte Islands	54.04 N	131.50 W
Yaquina Bay	Central Oregon	44.37 N	124.04 W
Yes Bay	Southeast Alaska	55.54 N	131.47 W

Date	Station	Locality			Depth (*m*)
		British Columbia *Albatross* stations			
1888					
Aug. 29	2860	West of Queen Charlotte Islands	51.23N	123.34W	1603
31	2861	Northwest of Cape Scott	51.14N	129.50W	373
	2862	Fort Rupert	50.49N	127.36W	436
Sept. 25	2879	Northwest of Barkley Sound	48.53N	125.48W	62
	2880	"			
	2881	Northwest of Amphitrite Point	49.00N	125.48W	44
1889					
Sept. 3	3342	West of Moresby Island	52.39N	132.38W	2906
1891					
Aug. 27	3444	Off Race Rocks	48.16N	123.29W	146
28	3447	Off Port San Juan	48.30N	124.36W	212
Sept. 2	3459	South of Port San Juan	48.24N	124.24W	225
	3460	West of Jordan River	48.25N	124.10W	97
4	3465	East of Victoria	48.21N	123.14W	88
		William J. Stewart stations			
1934					
June 19	2231-19	Off Maquinna Point, Nootka Sound	49.31N	126.48W	73
1935					
June 8	3514	Entrance SW Arm Tasu Sound	52.46N	132.01W	–

PARTIAL SYNONYMY

PARTIAL SYNONYMY

SUBORDER NATANTIA

SECTION PENAEIDEA

Family PENAEIDAE (Subfamily ARISTAEINAE) (Series BENTHESICYMAE)

- *Bentheogennema borealis* (Rathbun, 1902)
  - *Gennadus borealis* Rathbun 1902 (217), 1904 (219)
  - *Bentheogennema borealis,* Burkenroad 1936 (48), Wasmer 1972 (273), Aizawa 1974 (4)
- *Bentheogennema burkenroadi* Krygier and Wasmer, 1975
  - *Bentheogennema* species, Wasmer 1972 (273)
  - *Bentheogennema burkenroadi* Krygier and Wasmer 1975 (162)

Family SERGESTIDAE

- *Sergestes similis* Hansen, 1903
  - *Sergestes atlanticus* Bate 1888 (26) (part)
  - *Sergestes similis* Hansen 1903 (107), Schmitt 1921 (232)
  - *Sergestes (Sergestes) similis,* Yaldwyn 1957 (291), Milne 1968 (190), Wasmer 1972 (273)
  - *Sergestes similis,* Omori 1974 (200)
- *Sergia tenuiremis,* (Krøyer, 1855)
  - *Sergestes tenuiremis* Krøyer 1855
  - *Sergestes (Sergia) tenuiremis,* Yaldwyn 1957 (291), Wasmer 1972 (273)
  - *Sergia tenuiremis*, Omori 1974 (200)

SECTION CARIDEA

Family PASIPHAEIDAE

- *Pasiphaea pacifica* Rathbun, 1902
  - *Pasiphaea pacifica* Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232), Burukovsky 1976 (49)
- *Pasiphaea tarda* Krøyer, 1845
  - *Pasiphaea tarda* Krøyer 1845, Sivertsen and Holthuis 1956 (237), Wasmer 1972 (273)
  - *Pasiphaea princeps,* Smith 1884 (243) Rathbun 1904 (219)
- *Parapasiphae sulcatifrons* Smith, 1884
  - *Parapasiphae sulcatifrons* Smith 1884 (243), Chace 1940 (69), Wasmer 1972 (273) Crosnier and Forest 1973 (80)

Family OPLOPHORIDAE

- *Acanthephyra curtirostris* Wood-Mason, 1891
  - *Acanthephyra curtirostris* Wood-Mason 1891, Chace 1940 (69), Wasmer 1972 (273)
- *Notostomus japonicus* Bate, 1888
  - *Notostomus japonicus* Bate 1888 (26), Stevens and Chace 1965 (251), Wasmer 1972 (273)
- *Systellaspis braueri* (Balss, 1914)
  - *Acanthephyra braueri* Balss 1914 (18)
  - *Systellaspis braueri,* Balss 1925 (19), Chace 1940 (69), Wasmer 1972 (273)

Systellaspis cristata (Faxon, 1893)
  Acanthephyra cristata Faxon 1893 (87), 1895 (88)
  Systellaspis cristata, de Man 1920 (179), Figueira 1957 (90), Wasmer 1972 (273)

Hymenodora frontalis Rathbun, 1902
  Hymenodora frontalis Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232), Wasmer 1972 (273)

Hymenodora glacialis (Buchholz, 1874)
  Pasiphae glacialis Buchholz, 1874
  Hymenodora glacialis, Rathbun 1929 (222), Wasmer 1972 (273)

Family CRANGONIDAE

Paracrangon echinata Dana, 1852
  Paracrangon echinatus Dana 1852 (82), Holmes 1900 (128)
  Paracrangon echinata, Rathbun 1904 (219), Schmitt 1921 (232), Vinogradov 1950 (266)

Argis lar (Owen, 1839)
  Crangon lar Owen 1839 (203)
  Nectocrangon lar, Stimpson 1860 (254), Rathbun 1904 (219)
  Argis lar, de Man 1920 (179), Squires 1964 (246)

Argis dentata (Rathbun, 1902)
  Nectocrangon dentata Rathbun 1902 (217), 1904 (219)
  Argis dentata, de Man 1920 (179), Squires 1964 (246)

Argis ovifer (Rathbun, 1902)
  Nectocrangon ovifer Rathbun 1902 (217), 1904 (219)
  Argis ovifer, de Man 1920 (179)

Argis alaskensis (Kingsley, 1882)
  Nectocrangon alaskensis Kingsley 1882 (154), Rathbun 1904 (219)
  Argis alaskensis, de Man 1920 (179)

Argis crassa (Rathbun, 1899)
  Nectocrangon crassa Rathbun 1899 (216), 1902 (217), 1904 (219)
  Argis crassa, de Man 1920 (179)

Argis levior (Rathbun, 1902)
  Nectocrangon levior Rathbun 1902 (217), 1904 (219)
  Argis levior, de Man 1920 (179), Squires and Figueira 1974 (250), Wicksten 1976 (281)

Sclerocrangon boreas (Phipps, 1774)
  Cancer boreas Phipps 1774 (209)
  Crangon boreas, Sabine 1821 (231)
  Sclerocrangon boreas, Holmes 1900 (128), Rathbun 1904 (219), de Man 1920 (179) Zarenkov 1965 (298)

Rhynocrangon alata (Rathbun, 1902)
  Sclerocrangon alata Rathbun 1902 (217), 1904 (219), de Man 1920 (179), Kozloff 1974 (159)
  Rhynocrangon alata, Zarenkov 1965 (298)

Crangon stylirostris Holmes, 1900
  Crangon stylirostris Holmes 1900 (128), Rathbun 1904 (219), de Man 1920 (179)
  Crago stylirostris, Schmitt 1921 (232)

Crangon dalli Rathbun, 1902
  Crangon dalli Rathbun 1902 (217), 1904 (219), de Man 1920 (179), Vinogradov 1950 (266)

Crangon franciscorum franciscorum Stimpson, 1856
  Crangon franciscorum Stimpson 1856 (252), Ortmann 1895 (202)
  Crangon franciscorum franciscorum, Rathbun 1902 (217) (by implication), 1904 (219), de Man 1920 (179)
  Crago franciscorum, Schmitt 1921 (232)

Crangon franciscorum angustimana Rathbun, 1902
  Crangon franciscorum angustimana Rathbun 1902 (217), 1904 (219), de Man 1920 (179)

Crangon alba Holmes, 1900
  Crangon alba Holmes 1900 (128), Rathbun 1904 (219), de Man 1920 (179)
  Crago alba, Schmitt 1921 (232)

Crangon nigricauda Stimpson, 1956
  Crangon nigricauda Stimpson 1856 (252), Holmes 1900 (128), Rathbun 1904 (219), de Man 1920 (179)
  Crago nigricauda, Schmitt 1921 (232)

Crangon alaskensis Lockington, 1877
  Crangon alaskensis Lockington 1877 (170), Rathbun 1904 (219), de Man 1920 (179)
  Crangon nigricauda, Holmes 1900 (128) (part)

Crangon communis Rathbun, 1899
  Crangon communis Rathbun 1899 (216), 1904 (219), de Man 1920 (179)
  Crago communis, Schmitt 1921 (232)
  Sclerocrangon communis, Derjugin and Kobjakowa 1935 (84), Vinogradov 1950 (266)

Crangon abyssorum Rathbun, 1902
  Crangon abyssorum Rathbun 1902 (217), 1904 (219), de Man 1920 (179)
  Crago abyssorum, Schmitt 1921 (232)

Metacrangon spinosissima (Rathbun, 1902)
  Crangon spinosissima Rathbun 1902 (217), 1904 (219), de Man 1920 (179) Wicksten 1977 (282)
  Crago spinosissima, Schmitt 1921 (232), Butler 1950 (50)
  Metacrangon spinosissima, Zarenkov 1965 (298)

Metacrangon variabilis (Rathbun, 1902)
  Crangon variabilis Rathbun 1902 (217), 1904 (219), de Man 1920 (179)
  Crago variabilis, Schmitt 1921 (232)
  Metacrangon variabilis, Zarenkov 1965 (298)

Metacrangon acclivis (Rathbun, 1902)
  Crangon acclivis Rathbun 1902 (217), 1904 (219), de Man 1920 (179)
  Crago acclivis, Schmitt 1921 (232)
  Metacrangon acclivis, Zarenkov 1965 (298)

Metacrangon munita (Dana, 1852)
  Crangon munitus Dana 1852 (82), Holmes 1900 (128)
  Crangon munita, Rathbun 1904 (219)
  Crangon (Sclerocrangon) munitus, Ortmann 1895 (202)
  Sclerocrangon munita, de Man 1920 (179), Yaldwyn 1960 (202)
  Metacrangon munita, Zarenkov 1965 (298)

Mesocrangon munitella (Walker, 1898)
  Crangon munitellus Walker 1898 (267), Holmes 1900 (128)
  Crangon munitella, Rathbun 1904 (219), de Man 1920 (179)
  Crago munitella, Schmitt 1921 (232)
  Mesocrangon munitella, Zarenkov 1965 (298)

- *Mesocrangon intermedia* (Stimpson, 1860)
  - *Crangon intermedius* Stimpson, 1860 (254)
  - *Crangon (Sclerocrangon) intermedius,* Ortmann 1895 (202)
  - *Sclerocrangon intermedia,* de Man 1920 (179), Derjugin and Kobjakowa 1935 (84), Vinogradov 1950 (266)
  - *Mesocrangon intermedia,* Zarenkov 1965 (298)

Family PANDALIDAE

- *Pandalopsis dispar* Rathbun, 1902
  - *Pandalopsis dispar* Rathbun 1902 (217), 1904 (219), Kobjakova 1936 (156)
- *Pandalus borealis* Krøyer, 1838
  - *Pandalus borealis* Krøyer 1838 (160), Stimpson 1857 (253), Rathbun 1904 (219)
  - *Pandalus borealis eous* Makarov 1935 (177), Vinogradov 1950 (266)
- *Pandalus goniurus* Stimpson, 1860
  - *Pandalus goniurus* Stimpson 1860 (254), Rathbun 1904 (219), Vinogradov 1950 (266)
  - *Pandalus dapifer* Murdoch 1884 (195), Rathbun 1899 (216)
- *Pandalus jordani* Rathbun, 1902
  - *Pandalus jordani* Rathbun 1902 (217), 1904 (219), Dahlstrom 1970 (81)
- *Pandalus tridens* Rathbun, 1902
  - *Pandalus montagui* Leach 1814 (164), Rathbun 1899 (216)
  - *Pandalus montagui tridens* Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232)
  - *Pandalus tridens,* Ivanov 1971 (145), Haynes 1979 (120)
- *Pandalus platyceros* Brandt, 1851
  - *Pandalus platyceros* Brandt 1851 (45), Stimpson 1857 (253), Rathbun 1904 (219), Schmitt 1921 (232), Butler 1970 (59)
  - *Pandalus pubescentulus* Dana 1852 (82), Smith 1880 (242), Holmes 1900 (128)
- *Pandalus hypsinotus* Brandt, 1851
  - *Pandalus hypsinotus* Brandt 1851 (45), Rathbun 1904 (219), Holthuis 1976 (133)
  - *Pandalus gracilis* Stimpson 1860 (254), Holthuis 1976 (133)
- *Pandalus stenolepis* Rathbun, 1902
  - *Pandalus stenolepis* Rathbun 1902 (219), 1904 (219), de Man 1920 (179)
- *Pandalus danae* Stimpson, 1857
  - *Pandalus danae* Stimpson 1857 (253), Smith 1880 (242), Walker, 1898 (267), Rathbun 1904 (219); Schmitt 1921 (232)
  - *Pandalus franciscorum* Kingsley 1878 (153), de Man 1920 (179)

Family ALPHEIDAE

- *Betaeus harrimani* Rathbun, 1904
  - *Betaeus harrimani* Rathbun 1904 (219), Hart 1964 (111)
- *Betaeus setosus* Hart, 1964
  - *Alpheus aequalis,* Holmes 1900 (128) (part)
  - *Betaeus harfordi,* MacGinitie and MacGinitie 1949 (175) (part)
  - *Betaeus setosus* Hart 1964 (111)

Family HIPPOLYTIDAE

- *Hippolyte clarki* Chace, 1951
  - *Hippolyte californiensis,* Rathbun 1904 (219) (part), Schmitt 1921 (232) (part), not *H. californiensis* Holmes 1895 (127)
  - *Hippolyte clarki* Chace 1951 (70), Squires and Figueira 1974 (250)

Spirontocaris prionota Stimpson, 1864
  Hippolyte prionota, Stimpson 1864 (255)
  Spirontocaris prionota Walker 1898 (267), Rathbun 1904 (219), Schmitt 1921 (232)
  Spirontocaris macrodonta Hart 1930 (109)

Spirontocaris truncata Rathbun, 1902
  Spirontocaris truncata Rathbun 1902 (217), Holthuis 1947 (129), Butler 1964 (55)

Spirontocaris holmesi Holthuis, 1947
  Spirontocaris bispinosa Holmes 1900 (128), Rathbun 1904 (219), Schmitt 1921 (232)
  Spirontocaris holmesi Holthuis 1947 (129)

Spirontocaris sica Rathbun, 1902
  Spirontocaris sica Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232), Holthuis 1947 (129), Butler 1964 (55)

Spirontocaris lamellicornis (Dana, 1852)
  Hippolyte lamellicornis Dana 1852 (82)
  Spirontocaris lamellicornis, Walker 1898 (267), Rathbun 1904 (219), Hayashi 1977 (115)

Spirontocaris snyderi Rathbun, 1902
  Spirontocaris snyderi Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232)

Spirontocaris ochotensis (Brandt, 1851)
  Hippolyte ochotensis Brandt 1851 (45)
  Spirontocaris ochotensis, Rathbun 1904 (219), Holthuis 1947 (129), Hayashi 1977 (115)

Spirontocaris arcuata Rathbun, 1902
  Spirontocaris arcuata Rathbun 1902 (217), 1904 (219), Holthuis 1947 (129), Vinogradov 1950 (266), Hayashi 1977 (115)

Lebbeus grandimanus (Brazhnikov, 1907)
  Hetairus grandimanus Brazhnikov 1907 (46)
  Hetairus grandimana, Kobyakova 1958 (157)
  Spirontocaris grandimana, Vinogradov 1947 (265)
  Lebbeus grandimanus, Holthuis 1947 (129), Kozloff 1974 (159)

Lebbeus groenlandicus (Fabricius, 1775)
  Astacus groenlandicus Fabricius 1775
  Spirontocaris groenlandica, Walker 1898 (267), Rathbun, 1904 (219)
  Lebbeus groenlandicus, Holthuis 1947 (129)

Lebbeus washingtonianus (Rathbun, 1902)
  Spirontocaris washingtoniana Rathbun 1902 (217), 1904 (219)
  Lebbeus washingtonianus, Holthuis 1947 (129), Wicksten 1978 (283)

Lebbeus schrencki (Brazhnikov, 1907)
  Hetairus schrencki Brazhnikov 1907 (46), Kobyakova 1958 (157)
  Spirontocaris schrencki, Vinogradov 1974 (265)
  Lebbeus schrencki, Holthuis 1947 (129)

Lebbeus zebra (Leim, 1921)?
  Spirontocaris zebra Leim 1921 (166), Rathbun 1929 (222)
  Lebbeus zebra, Holthuis 1947 (129)
  Lebbeus zebra? Butler 1964 (55)

Eualus macrophthalmus (Rathbun, 1902)
  Spirontocaris macrophthalma Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232)
  Eualus macrophthalmus, Holthuis 1947 (129), Butler 1961 (54)

Eualus barbatus (Rathbun, 1899)
  Spirontocaris barbata Rathbun 1899 (216), 1904 (219)
  Eualus barbatus, Holthuis 1947 (129)

Eualus biunguis (Rathbun, 1902)
  Spirontocaris biunguis Rathbun 1902 (217), 1904 (219)
  Eualus biunguis, Holthuis 1947 (129), Miyake and Hayashi 1967 (192)

Eualus avinus (Rathbun, 1899)
  Spirontocaris avina Rathbun 1899 (216), 1904 (219)
  Eualus avinus, Holthuis 1947 (129)

Eualus pusiolus (Kroyer, 1841)
  Hippolyte pusiola Kroyer 1841
  Spirontocaris pusiola, Rathbun 1904 (219), Vinogradov 1947 (265)
  Eualus pusiolus, Holthuis 1947 (129), Greve 1963 (105)

Eualus herdmani (Walker, 1898)
  Spirontocaris herdmani Walker 1898 (267), Rathbun 1904 (219)
  Heptacarpus herdmani, Holmes 1900 (128)
  Eualus herdmani, Holthuis 1947 (129)

Eualus berkeleyorum Butler, 1971
  Eualus berkeleyorum Butler 1971 (61)

Eualus townsendi (Rathbun, 1902)
  Spirontocaris gaimardii, Rathbun 1899 (216) (part)
  Spirontocaris townsendi Rathbun 1902 (217), 1904 (219)
  Eualus townsendi, Holthuis 1947 (129)

Eualus fabricii (Krøyer, 1841)
  Hippolyte fabricii Krøyer 1841
  Spirontocaris fabricii, Rathbun 1904 (219), Vinogradov 1947 (265)
  Eualus fabricii, Holthuis 1947 (129)

Eualus suckleyi (Stimpson, 1864)
  Hippolyte suckleyi Stimpson 1864 (255)
  Spirontocaris suckleyi, Rathbun 1904 (219)
  Eualus suckleyi, Holthuis 1947 (129), Vinogradov 1950 (266)

Heptacarpus tenuissimus Holmes, 1900
  Hippolyte gracilis Stimpson 1864 (255)
  Heptacarpus tenuissimus Holmes 1900 (128), Holthuis 1947 (129), 1969 (132)
  Spirontocaris gracilis, Rathbun 1904 (219), Schmitt 1921 (232)
  Hippolyte amabilis Lenz 1901 (168)

Heptacarpus carinatus Holmes, 1900
  Heptacarpus carinatus Holmes 1900 (128), Holthuis 1947 (129), Squires and Figueira 1974 (250)
  Spirontocaris carinata, Rathbun 1904 (219), Schmitt 1921 (232)

Heptacarpus stylus (Stimpson, 1864)
  Hippolyte stylus Stimpson 1864 (255)
  Hippolyte esquimaltiana Bate 1864 (25)
  Spirontocaris stylus, Rathbun 1904 (219)
  Heptacarpus stylus, Holthuis 1947 (129), Squires and Figueira 1974 (250)

Heptacarpus decorus (Rathbun, 1902)
  Spirontocaris decora Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232)
  Heptacarpus decorus, Holthuis 1947 (129)

- *Heptacarpus tridens* (Rathbun, 1902)
  - *Spirontocaris tridens* Rathbun 1902 (217), 1904 (219)
  - *Heptacarpus tridens,* Holthuis 1947 (129), Squires and Figueira 1974 (250)
- *Heptacarpus camtschaticus* (Stimpson, 1860)
  - *Hippolyte camtschatica* Stimpson 1860 (254)
  - *Spirontocaris camtschatica,* Rathbun 1904 (219)
  - *Heptacarpus camtschaticus,* Holthuis 1947 (129), Vinogradov 1950 (266)
- *Heptacarpus kincaidi* (Rathbun, 1902)
  - *Spirontocaris kincaidi* Rathbun 1902 (217), 1904 (219), Schmitt 1921 (232)
  - *Heptacarpus kincaidi,* Holthuis 1947 (129)
- *Heptacarpus littoralis* n.sp.
  - *Heptacarpus* species, Squires and Figueira 1974 (250)
- *Heptacarpus moseri* (Rathbun, 1902)
  - *Spirontocaris gaimardii,* Rathbun 1899 (216)
  - *Spirontocaris moseri* Rathbun 1902 (217), 1904 (219)
  - *Heptacarpus moseri,* Holthuis 1947 (129)
- *Heptacarpus sitchensis* (Brandt, 1851)
  - *Hippolyte sitchensis* Brandt 1851 (45)
  - *Spirontocaris sitchensis,* Rathbun 1904 (219), Hart 1930 (109)
  - *Heptacarpus sitchensis,* Holthuis 1947 (129), Squires and Figueira 1974 (250)
- *Heptacarpus paludicola* Holmes, 1900
  - *Heptacarpus paludicola* Holmes 1900 (128), Holthuis 1947 (129), Squires and Figueira 1974 (250)
  - *Spirontocaris paludicola,* Rathbun 1904 (219), Schmitt 1921 (232)
- *Heptacarpus stimpsoni* Holthuis, 1947
  - *Hippolyte cristata* Stimpson 1860 (254)
  - *Spirontocaris cristata,* Walker 1898 (267), Rathbun 1904 (219), Schmitt 1921 (232)
  - *Heptacarpus stimpsoni* Holthuis 1947 (129), Squires and Figueira 1974 (250)
- *Heptacarpus brevirostris* (Dana, 1852)
  - *Hippolyte brevirostris* Dana 1852 (82)
  - *Spirontocaris brevirostris,* Walker 1898 (267), Rathbun 1904 (219)
  - *Heptacarpus brevirostris,* Holmes 1900 (128), Holthuis 1947 (129), Squires and Figureira 1974 (250)

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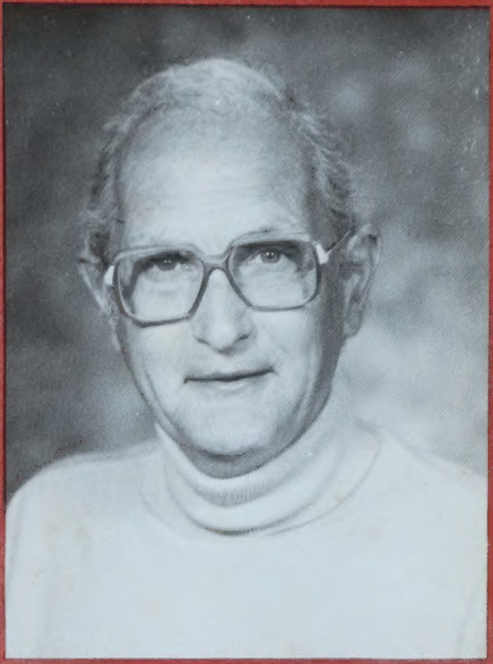

THE ARTIST

Alastair Alfred Denbigh was born in Japan and educated in England and Canada. He has had wide experience in the commercial and fine art fields. His marine and landscape paintings are in private collections in Canada, England, Australia, United States, and Japan. Mr. Denbigh is a scientific illustrator at the Pacific Biological Station, Department of Fisheries and Oceans, Nanaimo, B.C.